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PARTICULARS OF THE LONG ISLAND SOUND STEAMBOAT, CHESTER W. CHAPIN.

Newest among the fast freight and passenger steamers of Long Island Sound is the *Chester W. Chapin*, shown in the illustration on this page, steaming at a lively rate. This fine twin screw steamer is a product of the Maryland Steel Co.'s shipyard at Sparrow's Point, where she was built for the New Haven Steamboat Co. By an arrangement recently entered into the New York, New Haven and Hartford R. R. has secured control of the steamboat company, so that thenceforth the vessels of the company will be operated in harmony with the all-rail interests. This transfer gives practical control of all the Sound passenger lines of steamboats, plying between New York and New England ports, to the Vanderbilt railroad interests.

LONG ISLAND SOUND TWIN SCREW STEAMBOAT CHESTER W. CHAPIN UNDER STEAM.

Though the New Haven Steamboat Co. is a very old established corporation, dating, we believe, from 1821, it is only within about 12 months that it extended its service from New York to Providence, R. I., via New Haven, Conn. To enable the company to maintain this additional service the *Chester W. Chapin* was constructed. She is practically a duplicate of the widely known Sound steamer *Richard Peck*, with a slight increase in dimensions, and such modifications in interior design and arrangement as experience with the older boat suggested. The general dimensions are as follows: Length on water line, 310 ft.; length on deck, 324 ft.; beam at water line, 48 ft.; beam over guards, 64 ft.; depth moulded at lowest point of side sheer, 17 ft. 2 1-2 in.; draft loaded, 10 ft. 6 in.; tonnage, 2,868 tons gross; 1,822 tons net.

The hull is of mild steel throughout, the scantlings conforming to the highest requirements of the United States standard register, rating A for 20 years. In the accompanying deck plans the accommodations are very clearly shown. The *Chester W. Chapin is* a very comfortable boat and steady in a seaway, being fitted with bilge keels.

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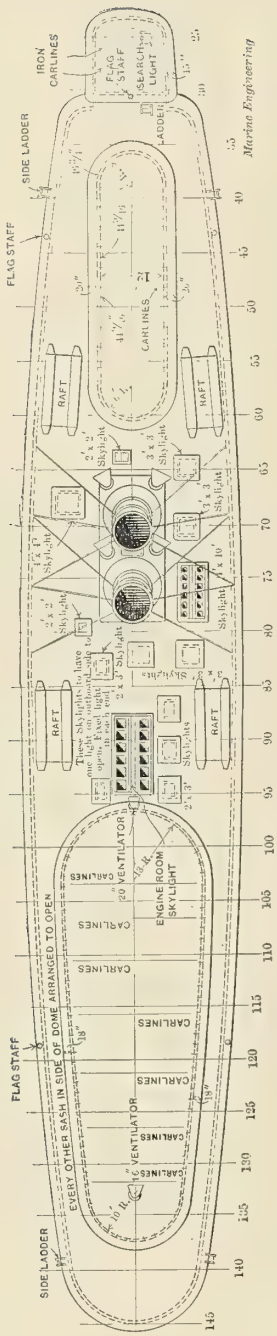
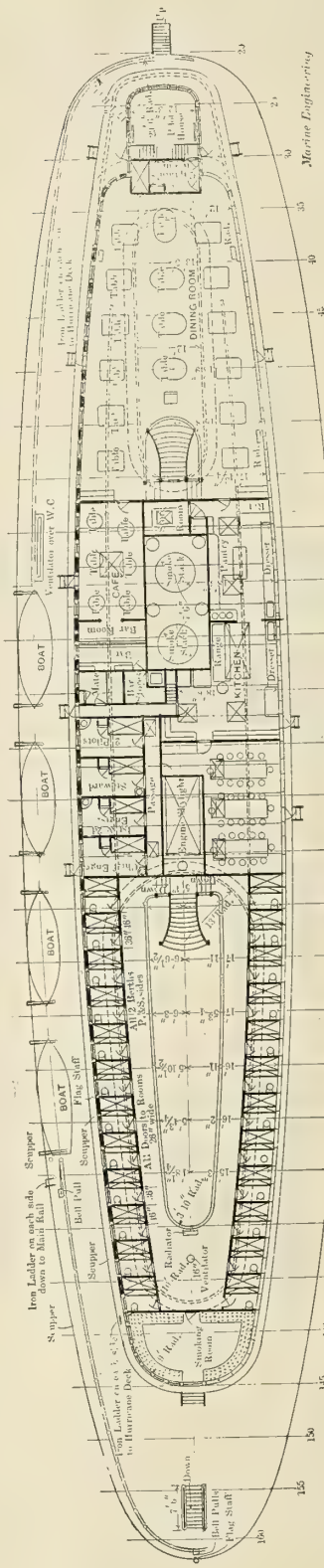
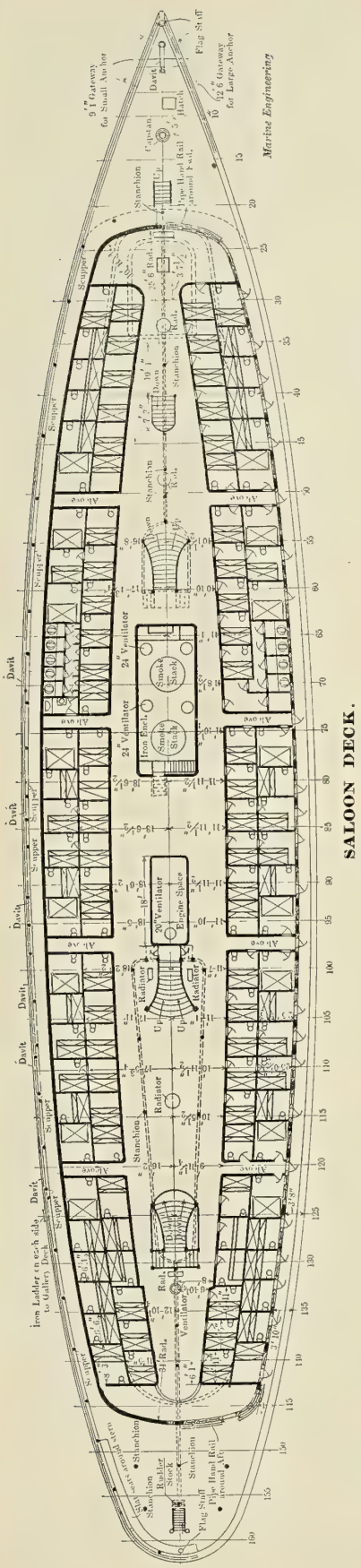
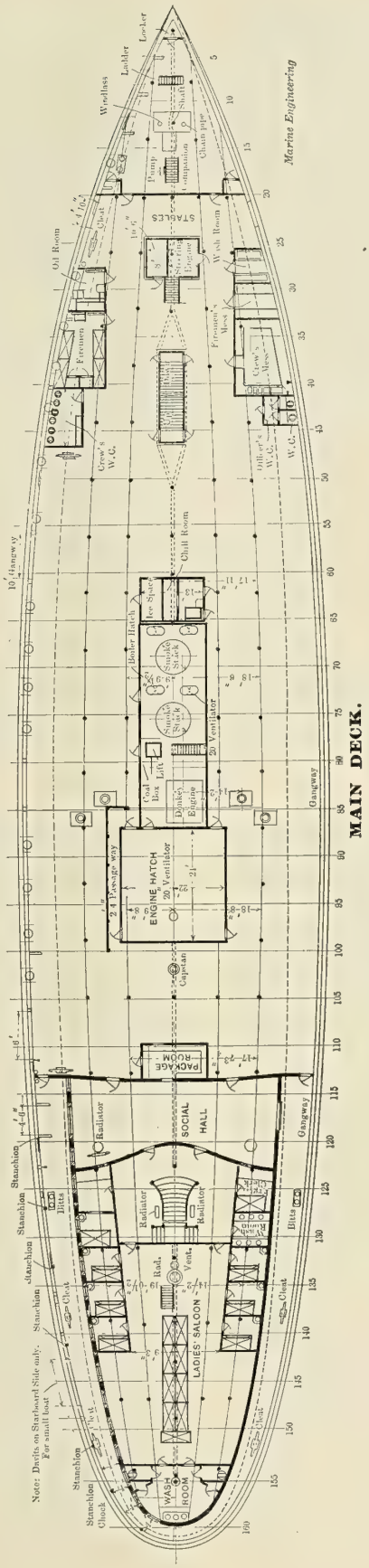


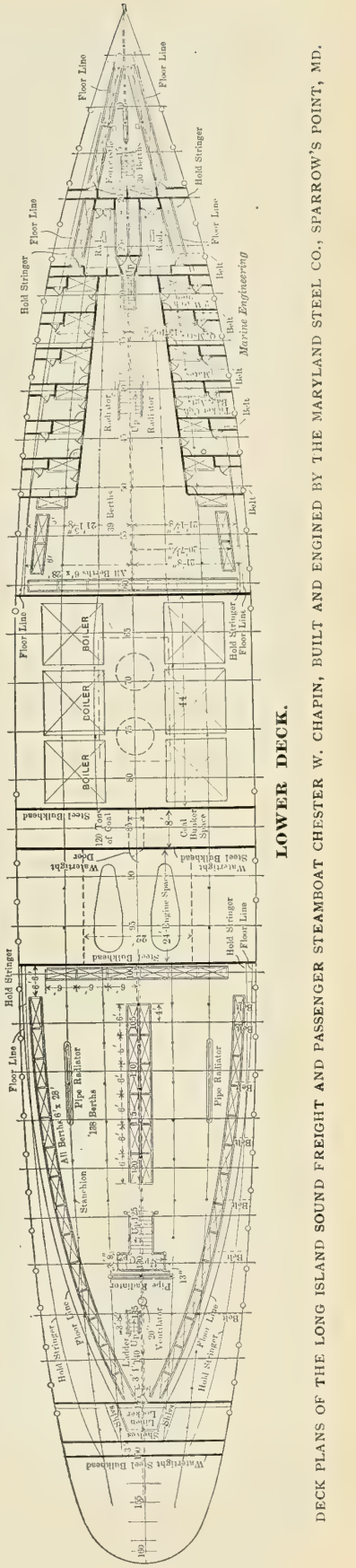
HURRICANE DECK.



GALLERY DECK.







DECK PLANS OF THE LONG ISLAND SOUND FREIGHT AND PASSENGER STEAMBOAT CHESTER W. CHAPIN, BUILT AND ENGINED BY THE MARYLAND STEEL CO., SPARROW'S POINT, MD.

In the accompanying reproductions of photographs of the interior the simple elegance of the decorations is apparent, though of course, the color effects are lost, and these add materially to the ensemble. In the main saloon the prevailing tone is old rose relieved with gold leaf. The carpets and hangings are a rich red, and the furniture is of polished mahogany to match. A feature of the arrangements much appreciated by travelers is the location of the dining room on the gallery deck, this being a really fine room, with seating capacity for about 200 passengers.

All modern conveniences, such as steam heating and electric lighting, are installed. The lighting plant has a capacity of 650 15 C. P. incandescent lights, and an 8,000 C. P. searchlight, mounted on top of the pilot house forward.

The propelling machinery consists of two sets of triple expansion surface condensing engines, with cylinders 24 in., 38 in. and 60 in. dia., and 30 in. stroke, of about 4,200 collective horse power. Steam is supplied at 170 lb. working pressure by six boilers, 13 ft. dia., and 12 ft. long, having 390 ft. grate surface and 11,562 sq. ft. heating surface.

The life-saving equipment includes eight 22 ft. life boats, four 16 1-2 ft. life rafts, one 16 ft. cedar dinghy, and 1,100 life preservers.

Designs for the vessel were gotten out by Cary Smith & Barbey, of New York.

Hamburg American Line.—Already in possession of an enormous total of new steam tonnage, the Hamburg American Line is actively engaged in increasing its fleet of ocean vessels. It has now under construction 25 steamships, which in themselves would form a fleet of the first magnitude. The names and tonnage of the vessels are as follows:

	Tons
Abessinia	5,500
Acilia	5,500
Alexandria	5,500
Artemisia	5,500
Belgia	7,500
Deutschland	16,000
Hamburg	10,640
Kiauchau	11,150
Prinzessin Victoria Luise	5,000
Segovia	5,960
Silvia	6,725
Sithonia	6,725
Stiria	5,960
12 new steamers building not yet named	81,825
Total	179,485

The *Deutschland* is, of course, for the New York fast express service of the company; the *Hamburg* and *Kiauchau* are for the East Asiatic service. The *Prinzessin Victoria Luise* is the new cruising yacht which will make her first trip through the Suez Canal to San Francisco, and will return to Germany by the same route. The other steamers are destined for the different services on the north and south Atlantic and on the Pacific oceans.

Institute of Marine Engineers.—At the eleventh annual meeting of the Institute of Marine Engineers, London, England, the election of officers took place, and the following will serve during the session of 1900-1901: President, Col. John M. Denny, M. P.; Honorary Treasurer, F. W. Shorey; Honorary Secretary, James Adamson. The secretary's report showed a membership of all classes of over 1,000, and a healthy financial condition.

THE NAVAL STEAM ENGINE—ITS GRAPHICS AND ECONOMICS ILLUSTRATED—I.

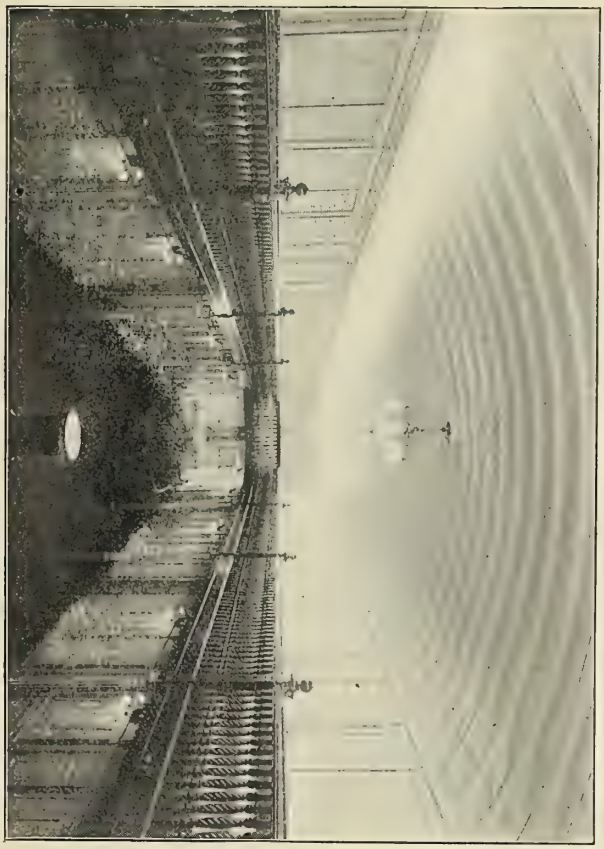
BY ROBERT H. THURSTON.

The analysis of thermal and dynamic energy-distributions in the steam-engine into useful and wasted energies, and the tracing of the stream from its source in the fuel at the boiler-furnace to and through the steam and the engine-piston and on to its work, or, unutilized from the steam and the engine-cylinder into the condenser or out into the atmosphere, has strongly attracted the attention of every intelligent engineer since the time of Watt, whether engaged in the design and construction, in its erection, operation, or in the scientific study of its theory. James Watt was the first to make a scientific investigation of the nature and extent of the wastes of the steam-engine and to reveal their cause, their method and their remedy. Since his time every engineer of reputation has given more or less attention to the subject, endeavoring to ascertain the quantities of energy utilized and wasted, the quantities of wastes remaining to be reduced, the laws of the variation of wastes and utilities, and the processes available for their modification with a view to the amelioration of the defects of the machine and its approximation in structure and performance to the ideal thermodynamic machine.

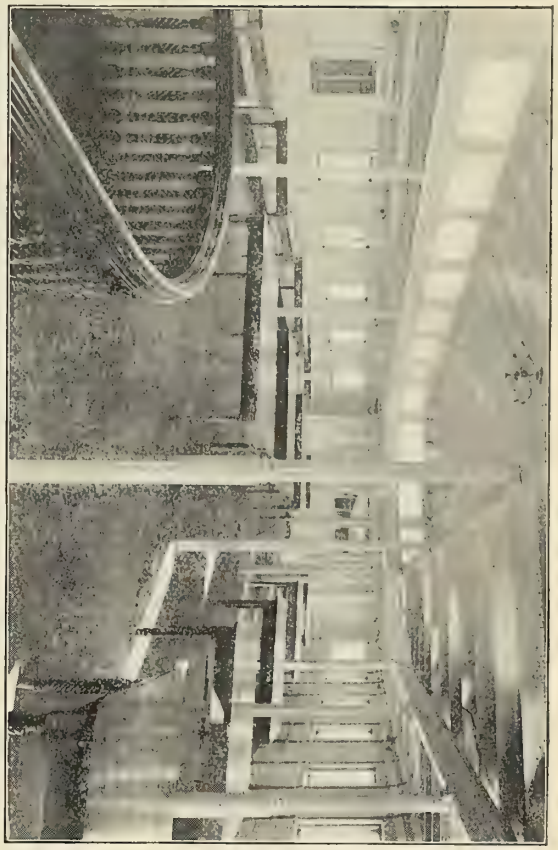
Daniel Kinnear Clark in Great Britain (1852), G. A. Hirn in France (1885), and especially, and by far most completely, Benjamin F. Isherwood in the United States (1859-65), revealed those laws by experimental investigation. Their work has been nobly supplemented by Emery and Dwelshauvers-Dery, and their successors; while Cotterill has shown how to reduce to scientific form and expression the resulting data. It is now practicable to construct a balance-sheet of energies received and expended in such manner as account for wastes and utilities with great precision.

The marine steam-engine has always interested layman and professional alike, more, probably, than any other form of the machine, partly because of its peculiarly striking and romantic duty and the imposing results attained, partly in consequence of the fact that it represents, we may safely affirm, the highest development and illustration of the inventive power of the modern mechanic and engineer, and largely because of the enormous power and striking perfection and economy which it has hitherto exhibited when compared with other forms of the heat-motors. The requirements and the limitations of the case are such, in the application of the marine steam-engine to its work, as to compel the most extraordinary possible combination of power, condensed into minimum space and with minimum weight, yet with maximum economy in the use of fuel and in cost of operation.

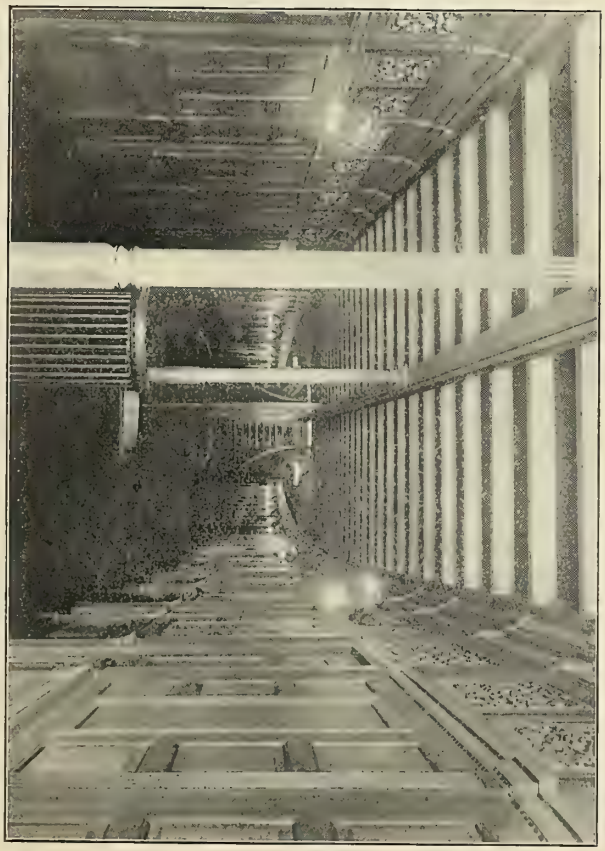
The following study has special interest as relating to the machinery of a noted modern iron-clad of great size, power and speed, as well as general efficiency—the late U. S. S. *Maine*. In comparing the work of such engines, however, with that of engines noted for their extraordinary economy in the use of steam and of fuel, regardless of their size or weight or the magnitude of their boiler-outfit, it is to be remembered that, in the case of the man-of-war, and particularly of



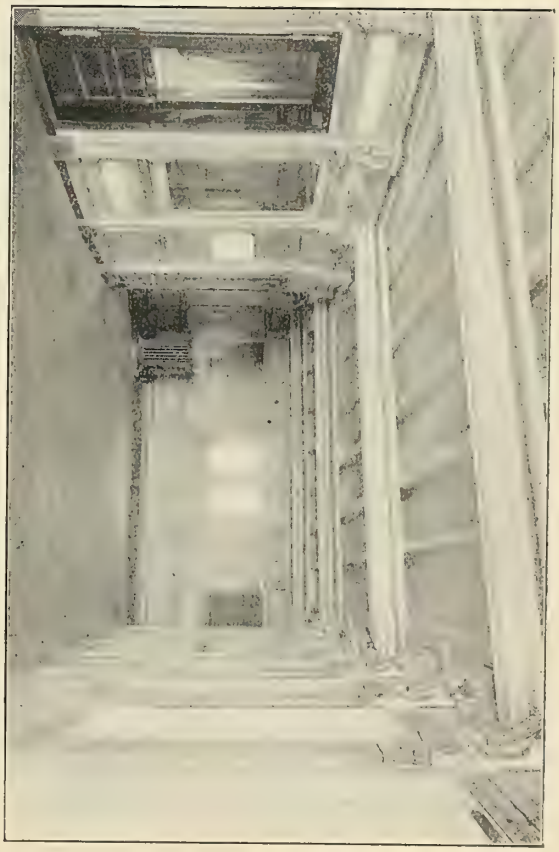
Main Saloon and Gallery.



Dining Saloon.



Main Saloon Forward.



Social Hall.

VIEWS OF INTERIOR OF LONG ISLAND SOUND STEAMBOAT CHESTER W. CHAPIN, BUILT AND FITTED OUT AT THE SHIPYARD OF MARYLAND STEEL CO., SPARROW'S POINT, MD.—SEE PAGE 183.

the iron-clad warship, economy of fuel and of steam at full power is not usually so important as when long voyages are to be undertaken at half-speed. The cruises of war-vessels are made at moderate speed and under restricted powers and maximum economy at high speeds is not important, since it is only in action, and for a few hours at most, at any one time, that the utmost power and speed of the ship are exacted. Economy under such circumstances may therefore be wisely sacrificed, to some extent, to concentration of power into small space and weight. The "record" for maximum efficiency is not held by this class of vessels, or, indeed, by marine engines of any class. While it is true that long-voyage freighters exhibit, properly, great economy of fuel, the highest figures, to date, are given by stationary engines, by steam pumping engines, as always since the days of James Watt. In the merchant service, nevertheless, the inducements to secure high economy are exceptionally great. The first cost of fuel is great, comparatively, since it must always be of good quality. It must be economized, not only because expensive, but also because every pound weight and every cubic foot of space occupied displaces a pound or a cubic foot of paying freight. On the other hand, the engines and boilers also displace paying cargo, and must be made as small and as light as may be found consistent with economy in the use of fuel. The whole design of a steamship, in fact, is a series of compromises between these various claims, and final results are more or less satisfactory accordingly as the net total outcome, measured on the books of the treasurer of the company, shows more or less earning power and a higher or lower ratio of returns to expenses of operation. Every principal proportion must be studied with reference to ability to improve permanently the dividend-earning power of the line. In the case of the war-steamer, the designer seeks the greatest possible concentration of power, a minimum weight and space with maximum power, or with a stated demanded power. Not only does such concentration lighten the ship; but in this case each pound saved or each cubic foot thus economized, gives opportunity to add to the battery or stores, or to increase the thickness of armor. Reduction of weight and volume to the lowest possible figures, and as high economy as is consistent with these primary aims, are the ends sought by the designer of the naval steamer. The following study of such a case will give some idea of the extent to which high thermodynamic efficiency is actually attained in such vessels.

Before taking up the data derived from the trial of the vessel, we will first see what would be the efficiency of a perfect thermodynamic engine, with steam pressure ranging, as during the progress of the marine engine since about the middle of the century, from, we will assume, 30 to 160 lb. per sq. in. absolute. The actual variation in customary steam pressures during this century is shown, as reported by a number of observers for this period, on the accompanying plate, Fig. 1.

It is found that steam pressures and efficiences are still rising, and the indications are, at present, that they will continue to rise for a considerable time to come. It is now possible to obtain safe steam-boilers for any pressure that may become usual and generally desired, and this has been, from the first, the real limit of advance in this respect. The introduction of the water-tube boiler of Stevens and Perkins has made pressures available that could not have been otherwise dreamed of.

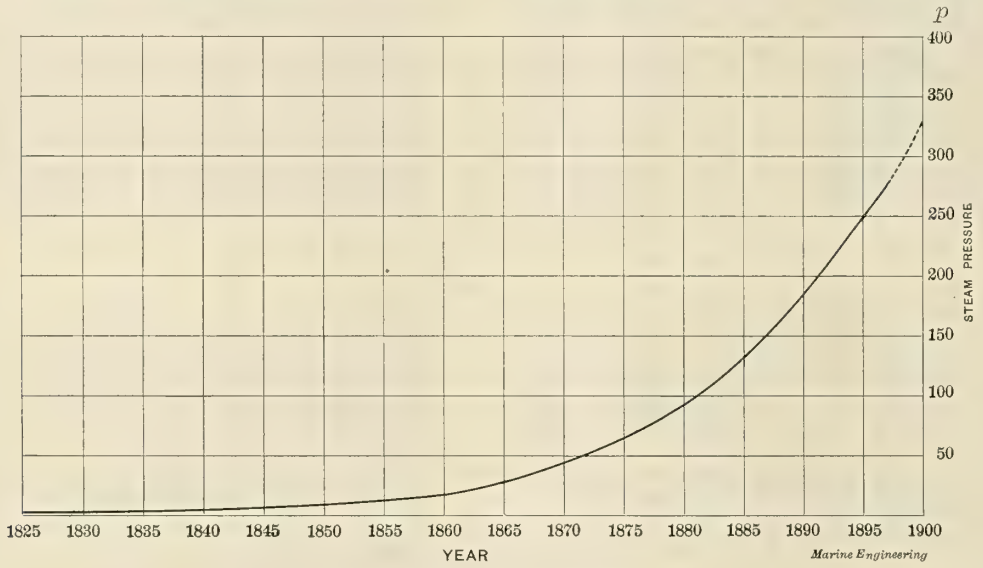


FIG. 1.—RISE IN STEAM PRESSURES.

The rise of pressure has been, on the whole, a fairly uniform one in rate and regularity during the generation just past, and, if this should continue another generation, the indications are that the year A. D. 1900 may see 300 lb., and possibly more in common use; and it would seem possible that only the approach to temperatures rendering our materials of construction no longer reliable may limit this advance. At the current rate of progress it will still be a century before we make standard those pressures which were experimentally employed, and with safety and comparative

economy, by Jacob Perkins a half-century ago. Forty years hence, the promise of our diagram is that customary pressures may be as high as 400 lb. per sq. in.—27 atmospheres. The sharp bend in the curve limits the period of the simple engine of James Watt, and marks the inauguration of the period of multiple-expansion engines. The steadiness with which the curve adheres to its uniformity of radius subsequent to that period would ordinarily be taken as evidence that we may fairly expect steady and uniform progress at a similar rate in the immediate future; but no one can say at what moment obstacles of insurmountable, or of slowly surmountable, character may arise to change the law of the curve. Perkins, however, in 1824-36, employed pressures of, first, 500 lb., then 1,000 lb., and finally of about 1,500 lb. per sq. in., with a ratio of expansion of 8, and obtained, as he says, one horse-power with but two bushels of coal per day, or less than two pounds per horse-power per hour, with but a fraction of the expansive action practicable to-day. With modern sectional boilers, and skill in design and construction, and guided by the light of modern science, now illuminating a then dark field so completely, it would be strange if our engine builders could not do better than Perkins, and enormously better than they are usually to-day doing.*

While increasing steam-pressures have been an important, an essential, element of progress, as securing better thermodynamic conditions, and have thus permitted a wider range of thermodynamic transformation, rising piston-speeds have as continuously aided in reducing the extra thermodynamic losses of the engine, and, contributing thus to the net result, have been, and still remain, one of the most important of the elements of high efficiency. The next illustration, Fig. 2, exhibits a diagram of the relation of piston-speeds to time which will forcibly present to the mind the relation of this economic condition to the progress already illustrated in improving duty. Not infrequently speeds have been adopted in marine work, especially, considerably higher than here shown, and 1,000 ft. a minute is not an uncommon figure in practice. This high speed of piston has the double advantage of reducing "cylinder condensation," and thus of making the constructor more or less independent of super-heating, of compounding and of jacketing as methods of its amelioration; while, at the same time, increasing speeds give increasing power in full proportion. Power is a product of the two factors, resistance overcome and speed of velocity of action. Of these two factors, speed is that which costs nothing in size, weight or expense of construction. A steam engine working at a speed of 500 ft. a minute has just one-half the power, and is considerably less economical, usually, than the same engine at 1,000 ft.

A standard of efficiency is required, in comparing the economical performance of steam-engines, precisely as a standard is needed for weights and measures, or for coinage. This standard has for its ultimate measure the "mechanical equivalent of heat," as Joule called it, the thermal equivalent of work, as it may just as well be called. Energy measured in the dynamic form, and the equivalent amount of energy in the thermal state, have the relation of equality between 778 foot-pounds of dynamic energy and one thermal unit in British measures (*B. T. U.*). With perfect transformation of heat into work, each unit will be found to produce, by its conversion into the other form of energy, 778 foot-pounds of work. Any heat-engine of perfect form and of perfect efficiency, of efficiency unity, would do work in this proportion to heat supplied it.

The above statement is equivalent to saying that 2,545 *B. T. U.* per hour are the equivalent of the horse power, 1,980,000 foot-pounds per hour. Similarly 42.42 *B. T. U.* per minute are the equivalent of the 33,000 foot-pounds per minute, which are conventionally taken by the engineer as equal to horse-power. The quantity of steam demanded per horse-power, at efficiency unity would depend upon the amount of heat supplied the feed-water, per pound, at the boiler. With a condensing engine, raising the temperature of the feed from that of the hot well and condenser to that of the boiler-steam, and evaporating it into steam at that pressure, the quantity of heat communicated per pound is commonly about one thousand thermal units, and the horse power demands from 2.3 to 2.5 pounds of steam per hour. This, again, is the equivalent of about one-quarter of a pound of good coal. These several measures of equivalence may be termed the several forms of expression of the *absolute* standard. But we need also standards of *relative* performance, by means of which to compare the efficiencies of the real engine with the computed efficiencies of the ideal machine of similar cycle. Of these standards, a number are found useful, each in its own way and for its special purpose.

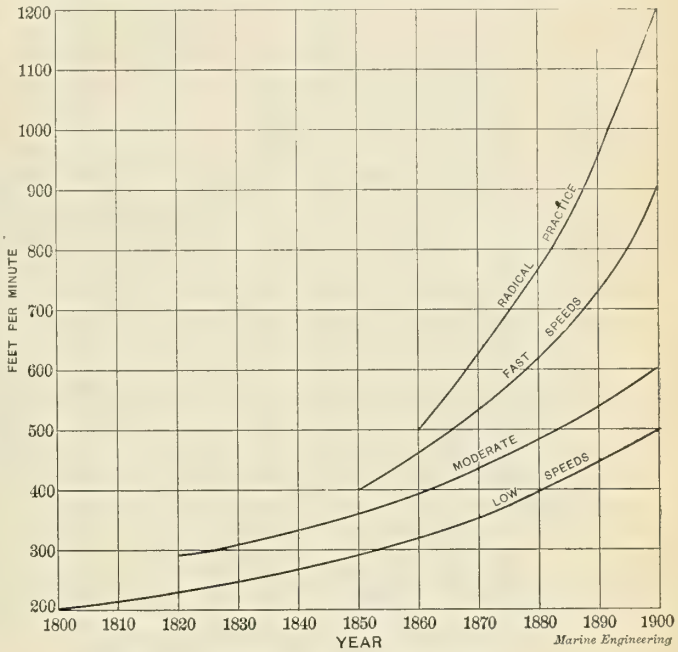


FIG. 2.—PISTON SPEEDS, 1800—1900 (MARINE).

*Perkins employed a Woolf compound engine as early as 1827, and for his latest work with his highest pressures. Had Perkins and Alban, the distinguished German engineer who followed in his track, employed larger expansion ratios and triple and quadruple expansion engines, it is more than possible that we should be to-day using, regularly and customarily, pressures exceeding these. Progress must apparently always be in that direction; we can see no way of increasing our engine efficiencies by reducing the lower limit of temperature and pressure.—R. H. T., Trans. A. S. M. E. Contemporary Economy of the Steam Engine.

The Carnot Cycle affords a relative standard by means of which the wastes of the real engine may be determined, so far as they are due to departures from the most perfect economic conditions and the most perfect possible thermodynamic cycle. Worked in this cycle, whatever the character of the working fluid, the efficiency is a maximum, and always measured by the ratio of the range of temperature worked through to the maximum, absolute, temperature of the cycle. In all cases we have a diagram composed of a pair of adiabatic lines, crossed by a pair of isothermals; all the heat received is taken into the system at the maximum, and all that is rejected is discharged at the minimum temperature, and transfer from isothermal to isothermal always occurs adiabatically. The difference between the heat received and that rejected is converted into work, and the ratio of work performed to heat supplied, the measure of efficiency, is given in turn by the difference of temperatures of reception and rejection, divided by the maximum temperature, on the absolute scale:

$$\text{Effic.} = (T_1 - T_2) \swarrow T_1.$$

Computing the quantity of heat or steam or fuel required in the given case for efficiency unity, the division of these quantities by the Carnot efficiency of the given cycle gives the measure of the maximum thermodynamic efficiency attainable by even a perfect engine, and the difference between the value of this efficiency and that of the real engine, with which comparison is made, affords a measure of the sum of all wastes, thermodynamic and extra-thermodynamic, so far as they constitute the economic difference between the ideal and the real engine.

In making such computations of efficiency, we require the following data only: the initial and final pressures and temperatures of the working fluid, and, for special purposes, the volumes of the fluid in the several states, and under the various conditions, marking critical points in the cycle. To determine the weights of steam and of fuel, the sensible and latent heats must be ascertained by consultation of the "steam-tables" and the quality of the fuel, as determined by chemical analysis, or by combustion, for the ideal case, and by a steam-boiler trial for the real engine, must be accurately determined.

The Carnot efficiencies being thus computed, the comparison of these figures with those resulting from a trial of the engine will furnish a measure of the relative value of the latter, of the nature and magnitude of its wastes, and of the range remaining for further improvement.

A relative standard of efficiency of still more actual value, perhaps, is the ideal case as computed on the assumption that an engine can be made of similar cycle with that adopted in the actual case, but free from extra-thermodynamic wastes.

U. S. S. Kearsarge.—On a two hours full power trial, natural draft, the U. S. S. *Kearsarge* gave the following results: Average revolutions, starboard, 98.7; port, 96.9; vacuum, starboard, 26 in.; port, 25.5 in.; steam pressure, 154 lb.; coal per hour, 18,480 lb.; I. H. P., 8,483.35; main and auxiliary engines, coal per I. H. P., 2.18 lb.; average speed, 14.99 knots. The mean draft when leaving port for trial was 23 ft. 7 in. Pocahontas coal was used.

MAIN OFFICE BUILDING OF THE NEW YORK SHIPBUILDING CO., CAMDEN, N. J.

Since the purchase of a site for the new shipyard at Camden, N. J., the New York Shipbuilding Co. has been unceasingly at work getting the plant ready for operation. The site selected covers, as our readers will recall, about 120 acres, and field work was begun July 3 last. Pending the completion of the office building at the yard, headquarters were established in one of the large office buildings in Philadelphia, but these have now been transferred to the office at Camden, which has been completed and fully made ready for occupancy.

This building is of much interest to the engineer, as it has been laid out with a proper appreciation of the needs of a modern, up-to-date office, and the thoroughness which has marked all the operations of this company is displayed in both the design and equipment. The accompanying photograph gives a very good idea of the main office. The building is in the old colonial style, very appropriate in the section in which it is situated. It is located on a lot, 460 ft. by 210 ft., on the opposite side of the street from the main entrance to the yard. About 400 ft. distant the main shops are situated, with the street, the yard office, power house, and general store room intervening. Street car lines pass the door and connect with the Camden ferries to the city of Philadelphia, and stations of the Pennsylvania and Reading railway systems are located at the rear within three minutes walk.

The building is located 50 ft. back of the curb line, and is 130 ft. by 116 ft., and contains two stories and basement. The foundations are concrete with granite water table; the walls are dark red colonial brick, with thick cement joints, raked out and trimmed with Indiana limestone. The main entrance is also of Indiana limestone of colonial design, with heavy pediment.

In the accompanying floor plans the accommodations can be read at a glance. The interior finish of the building is of white oak quartered and finished dark. Great attention has been given throughout to the important feature of lighting. Walls and ceilings are painted in oil, with various shades of green, depending on the amount of light admitted to the rooms. The upper portion of every door and partition is of chipped glass. Chocolate colored plain linoleum is laid on the floors, and quartered oak, richly polished, is used for all the furniture.

A feature of the structure is a great fire proof vault, 40 ft. by 20 ft., and extending through three stories. In the lower floor such archives as will be seldom referred to will be stored. The middle story of the vault is divided into three compartments, for holding hull department drawings, engine department drawings, and for letters, estimates and other valuable papers. The upper story is divided into two compartments, and will be used for the storage of data and papers belonging to the cost and accounting department, and for the use of drawings pertaining to the construction and maintenance of the plant.

In the basement the entire south side is laid out in three dining rooms, occupying a space 120 ft. by 24 ft., with capacity for 200 persons at one sitting. One of these rooms is a private dining room, another the

dining room for the general officers, and the third is the general dining room. Kitchens and serving room, equipped with every modern convenience, a large refrigerator, and pantries, are conveniently placed.

On the north side of the basement the office engineer's room is located, also a bicycle room, approached by a slope, and a room 50 ft. square to be used for exhibiting ship appliances and fittings. One hundred separate lockers are situated along the main corridor for the use of the draughtsmen.

In the toilet rooms the newest sanitary appliances are fitted. One toilet room is located in the rear of the basement, and is reached by stairways from each of the drawing rooms; the other room is in the basement proper, and is approached by a stairway from each front corner of the building.

The first floor is exclusively for the use of the executive departments, and has separate accommodations for the engineers, draughtsmen, estimators and librarian; thus bringing together on one floor all employees engaged in securing work and in preparing data having reference to the output of the yard.

Special care has been taken in the arrangement of rooms so that each of the officers will be located conveniently to the various departments with which he will have frequent communication. By an inspection of the first floor plan, on page 191, for example, it will be noted that the president's office adjoins that of the private secretary and board room on one side, and the private library, superintending captain and general superintendent on the other side.

The functions of the superintending captain will be to advise with the president, general superintendent, naval architect, chief engineer and marine engineer with reference to the proper construction of ships and conveniences in arrangements and handling.

The office of the general superintendent is situated between that of the president and superintending captain on one side, and the estimator, naval architect, chief engineer, marine engineer, draughting rooms and librarian on the other.

Between the rooms of the executive officers and the draughting rooms come the quarters for the chief engineer, naval architect and marine engineer. This space extends over the entire length of the building—that is 130 ft.

On the other side of the first story are the offices for the cashier, treasurer, vice-president, purchasing agent and his clerks, and the librarian. These are arranged so that the purchasing agent is situated between the vice-president and treasurer on one side, and the clerks and librarian on the other.

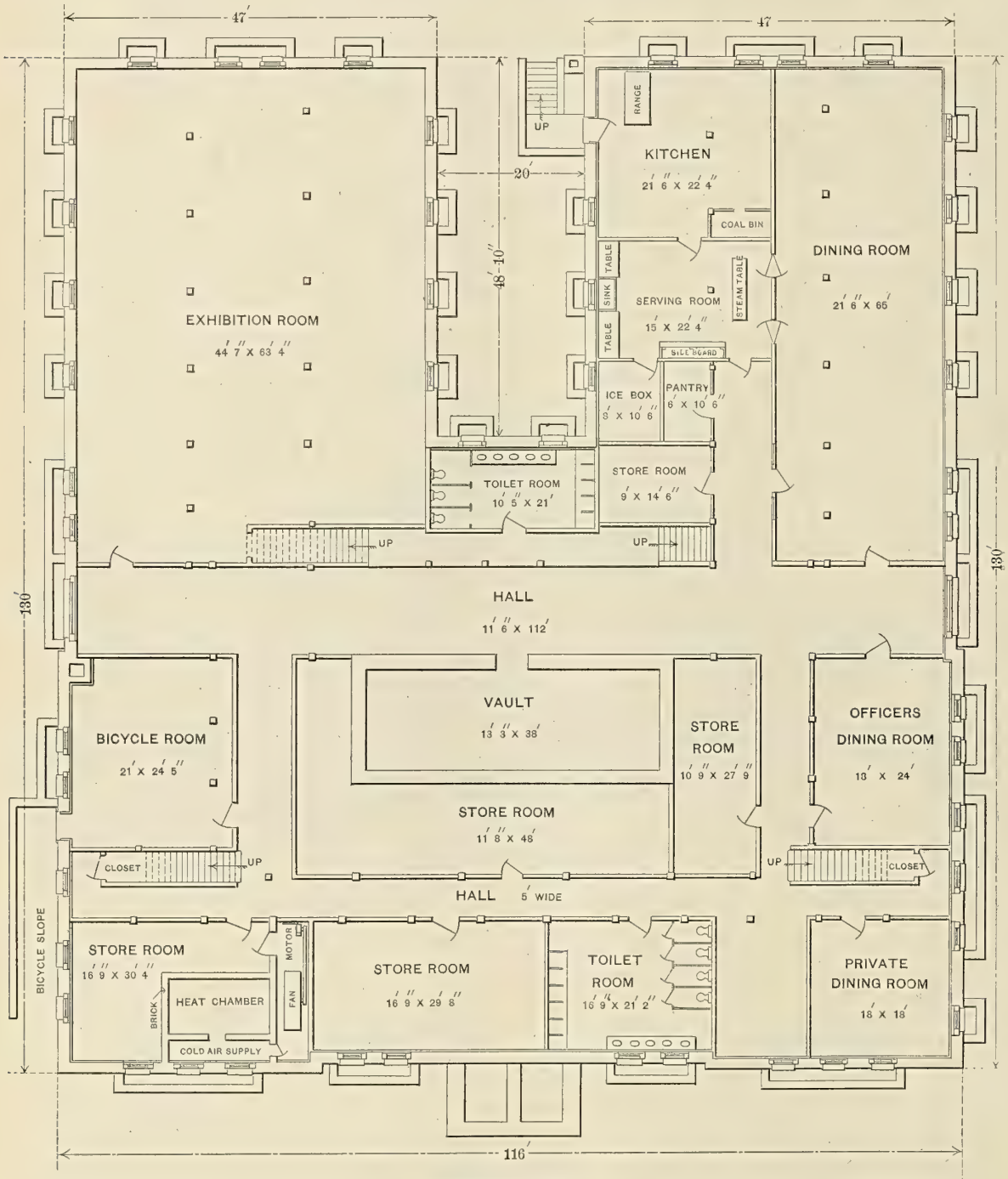
The duties of the librarian will be to take charge of all tracings, catalogues, books, estimates, letters, and in fact, all data for use by all the officers and employees.

MAIN OFFICE BUILDING OF NEW YORK SHIPBUILDING CO. AT CAMDEN, N. J.

A memorandum of all letters received will be made by him before distribution, all answers to letters will be copied by him, and the copies retained and filed. As soon as tracings are finished and approved they will be delivered to the librarian and blue print copies will be distributed on requisition, the blue printing department being entirely in his charge. All data pertaining to the purchasing department will be received, catalogued and classified by him and temporarily delivered to the purchasing agent for use. The librarian will also have charge of the general library and all periodicals. The latter will be purchased in triplicates, one copy being bound and filed in the library, the other two cut up and properly classified. The object of establishing this department is to relieve all the officers and stenographers of the burden of arranging, classifying and filing, and especially the remembering of such data as they are called upon to use frequently.

On the second floor the accounting department has large office space, and here also are the quarters for the staff occupied with the maintenance of the plant.

The secretary, whose office adjoins that of the accounting department, will have charge of all the bookficers' rooms is a separate draughting room for his special use. In the main body of the office on this floor there is a fine model room. In the north corner of the office there is extensive accommodations for blue printing and photographing department, which will be under



BASEMENT PLAN

Marine Engineering

BASEMENT PLAN OF MAIN OFFICE OF NEW YORK SHIPBUILDING CO.

keeping and cost accounting. Accommodations for the maintenance staff will include offices for the mechanical engineer, electrical engineer and civil engineer in charge of the yards and docks. Adjoining each of these of-

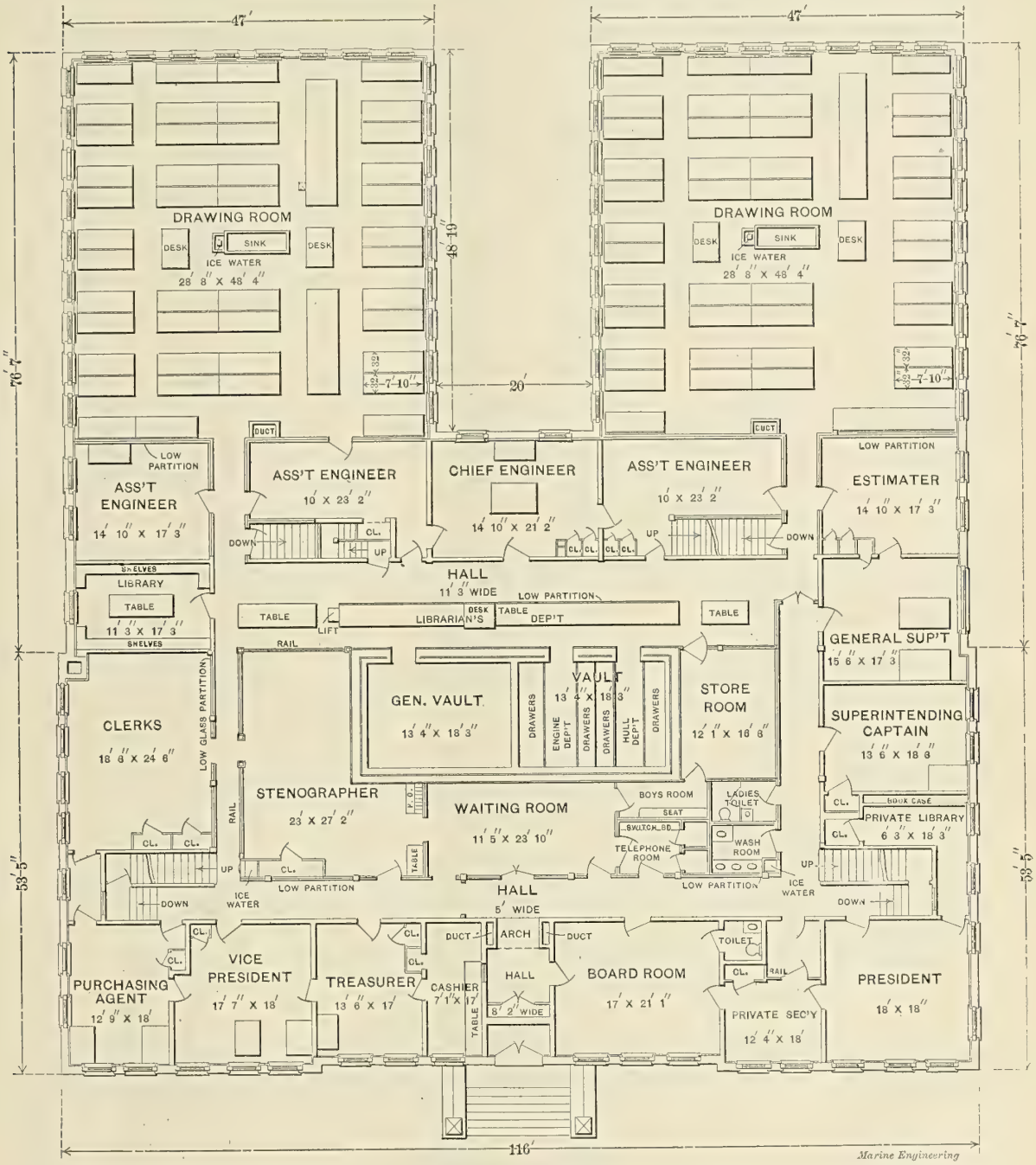
the control of the librarian, who will, also, have charge on this floor of the vault containing drawings and data for the maintenance of the plant.

In the southeast corner a tracing room is fitted, where

work of this character will be carried on, so as to relieve the draughtsmen of both the hull and engine departments.

An adequate water supply has been provided throughout the building. Each floor will be supplied with a contings are located conveniently for the use of the executive officers.

Heating and ventilation have been carefully considered in the design of the office. It will be heated in cold weather by exhaust steam from the power house, situ-

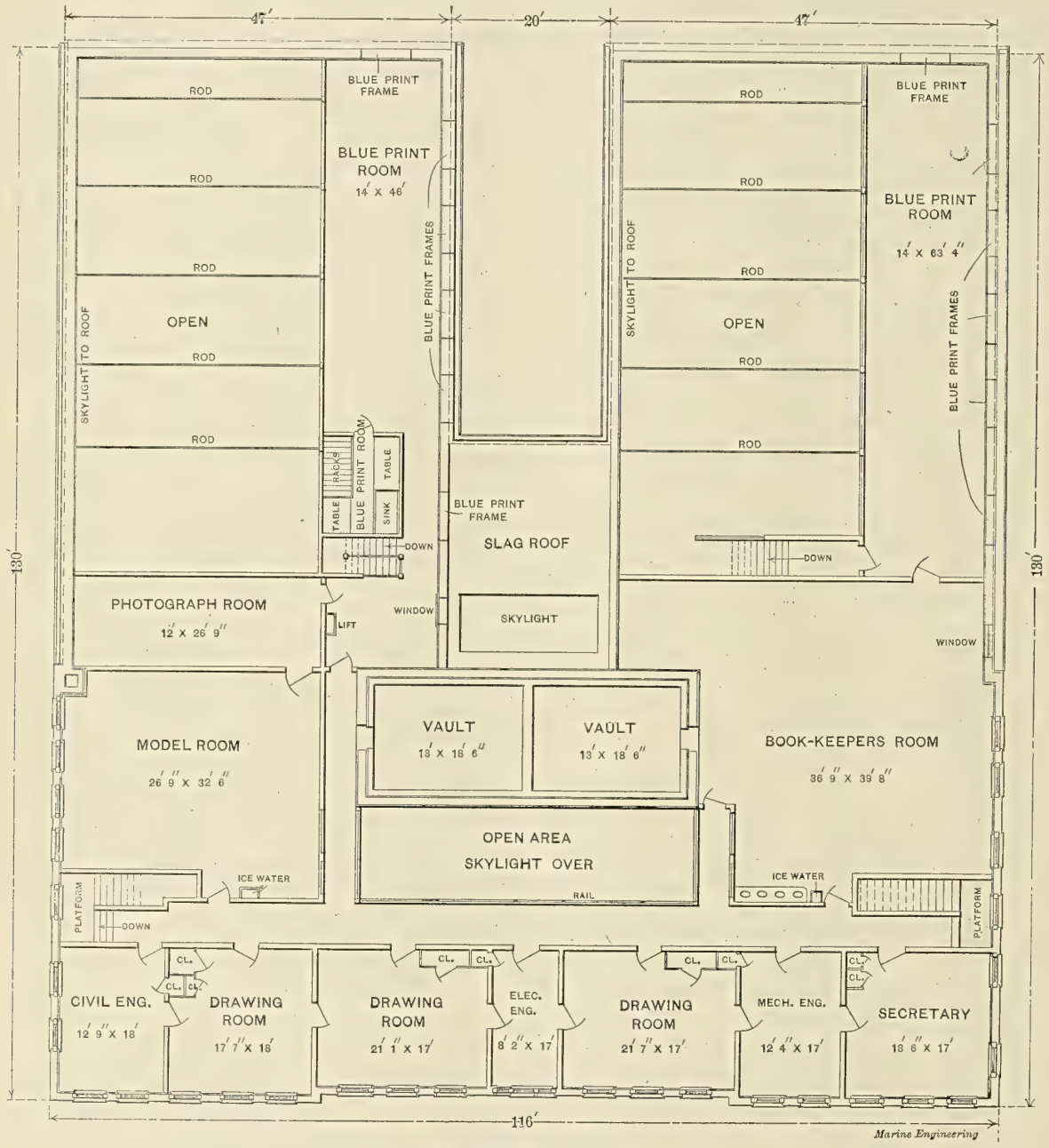


FIRST FLOOR PLAN

FIRST FLOOR PLAN OF MAIN OFFICE OF NEW YORK SHIPBUILDING CO.

stant flowing stream of water at a temperature of 55 deg., pumped from an artesian well. Wash rooms and drinking fountains of the two draughting rooms are situated in the center of each room, and other similar fitated 300 ft. distant, by both the direct and indirect systems. The indirect system consists of a heating chamber through which air from the outside of the building is drawn by a large fan and distributed to each room

in proportion to the number of occupants of the room. A sufficient quantity of air is forced in to effect a complete change of air in the room once in every five minutes. During the summer season this system will be used to keep the air fresh in the rooms. A direct system of heating by steam radiation is also provided in have a capacity for 130 telephones, of which 100 will be used in connecting the various offices of the main works and thirty in the office building proper. Each department in the office will have a connection through the central station with every other department by desk-phone, and with every part of the works where wall in-



SECOND FLOOR PLAN

SECOND FLOOR PLAN OF MAIN OFFICE OF NEW YORK SHIPBUILDING CO.

all rooms, but this will only be needed in excessively cold weather.

For purposes of quick communication throughout the entire plant a very complete telephone system has been installed, with the central station located in the main office on the first floor. This, when completed, will

struments will be fitted. For lighting the office the building is wired for direct current, and incandescent lamp fixtures are fitted wherever needed, the current being supplied from the power house in the yard.

In a description on paper it is not possible to cause a full appreciation of the facilities in the building for

effective and convenient operation, such as would be experienced by a personal inspection. To those who have had experiences with old time shipyard facilities the new building would seem a creation of fancy rather than fact, so completely does it meet the needs of modern work. The size of the building can be better appreciated by a comparison which shows that the two upper floors are in dimensions equal to 100 rooms, 15 ft. by 15 ft., or floor space equivalent to a 40 ft. by 60 ft. building ten stories high.

The architects of the building, as well as of the main shops, are Hale & Amory, 15 Exchange St., Boston, Mass., and Henry G. Morse, Jr., associate architect, has direct charge of the construction and arrangements on the ground. The general constructor for the building is the J. S. Rogers Co., Camden, N. J.

ONE AND TWO-WIRE SYSTEMS OF ELECTRIC DISTRIBUTION, COMPARATIVELY DISCUSSED.

BY ALTON D. ADAMS.

The fact that the largest steamship in the world, the *Oceanic*, has recently been fitted with an electric plant for which the hull serves as one set of main and branch conductors between the dynamos, lamps and motors, emphasizes the claims of advantage made for the one-wire system of ship lighting.

The usual American practice in ship plants is to run a complete, copper circuit of two insulated wires, to which the dynamos, lamps, and all current-consuming devices are connected. This system has no electrical connection with the hull of the ship; both terminals of the dynamos are carried to the switchboard and double pole switches and fuses are provided for all circuits.

In the one-wire system of ship lighting, one terminal of each dynamo, usually the negative, is connected directly with the steel hull of the ship, commonly by a contact plate in which a cable from the dynamo terminates. The other, or positive dynamo terminal, is carried to the switchboard and connected through single pole fuses and switches with each of the wires leaving it. The single wires going from the switchboard each represent one side of a circuit for which the hull of the ship is the other. Each wire connects with its group of lamps, motors or other devices, and the other terminal of each lamp or motor is secured to the ship's hull.

The advantages of the one-wire system include a saving in both materials and labor. As all of the switches are single pole, the weight of their metal parts is only about one-half of that for double-pole switches. Fuses also being single pole, their parts require only about one-half the weight and space of the two-pole type. The smaller number of switch and fuse parts require a smaller and more simple switchboard for mounting them, also smaller distribution panels at other points. The greatest saving of materials effected by one-wire plants is in the weight of copper required for distribution.

The weight of wire required for the circuits of electric plants varies inversely as the electric pressure or volts consumed between their terminals, when the full rated current is flowing, other factors remaining constant. As two wires of equal size and weight connect each lamp or motor with the dynamos, the use of the ship's hull for one side of the circuit reduces the total weight of wire one-half, provided the sizes of wires used for the other side of the circuit remain the same as in the two-wire system. The loss in a wiring system, however, is properly decided on questions of lamp regulation, heating of conductors and power loss, so that the same loss of pressure in the entire circuit is desirable whether the two-wire system or the one-wire with hull return be used. Hence it is said that, since the electrical resistance of the hull is very small, the resistance of the wires in the one-wire system may be twice as great as that of one-half of the circuit in the two-wire system; that is, may equal the entire resistance of the two-wire system. If this claim is correct the wires of the one-wire system with hull return may be of only one-half the size of those in an equivalent two-wire system, for the same loss of power and pressure, and the weight of copper necessary for the one-wire plan is, therefore, only one quarter of that with two wires or a complete copper circuit.

Simple as it thus appears to save seventy-five per cent of the weight of copper necessary for two-wire ship circuits, there are very good reasons why no such saving can be made in practice, for the great majority of cases. A suitable loss of pressure in the wiring of ship plants usually ranges from two to five volts at full load, being largely decided by considerations of pressure regulation at lamps as well as some regard for loss of power. There is, however, another important factor that cannot be ignored, namely, the safe carrying capacity of the wires; that is the rate at which current, as measured in amperes, may flow through them without causing so great a rise of temperature that they become a source of danger as to fire. Now the safe carrying capacity of a given wire is a constant quantity under the same conditions, depending upon its sectional area and the kind and quantity of its insulation, while the maximum loss of pressure that may occur in a conductor varies directly with its length, and may be very small if the conductor is quite short. In the design of the two-wire system for ship plants with losses of from two to five volts pressure in the wiring, the permitted pressure loss determines in most cases the size of conductors, rather than considerations of safe carrying capacity. The practical effect of the hull return is to cut the length of wires in two, so that if the same loss is to be had in the wires of the one-wire system that would be allowed in the two-wire system for the same service, it will often be found that the permitted loss involves too great a rise of temperature in the wires, and is, therefore, larger than is permissible. In this case the only course is to select some larger wire whose safe carrying capacity will not be exceeded by the desired flow of amperes. In many cases, for the distances common in ship plants, this limit as to safe ampere capacity of wires will be found to require about the same sizes of conductors in many parts of the one-wire system as would be used for the two-wire.

Another practical limit to the reduction of the areas of wires in the one-wire plan is found in the fact that, for mechanical considerations as to strength, the smallest wire that should be used for general purposes in either the one or two-wire system is about .064 in. dia.,

and much more of this particular size, as to length, will be used than of any other. The result of the considerations just named, together with the fact that the weight of insulation does not vary so fast as that of its contained copper wire, tends to keep the sizes of wires for the one-wire system and also their weight at about that in one-half of an equivalent two-wire circuit.

Even on the supposition that the hull of a ship offers no electrical resistance when used as the return for a wiring system, it is by no means possible, therefore, to reduce the section and weight of wire in the one-wire system to one-fourth of the amount required for the two-wire plan. A little consideration will show, however, that to regard the return circuit through the ship's hull as of no resistance is a mistake. One of the fixed rules for the erection of electric wires is that all joints between wires be soldered to insure a low resistance at these points. At switch, fuse and socket terminals clamp joints are permitted, but special contact parts of relatively large surface are provided at these places, and these clamping parts are always of brass or copper, the surface of which is much less subject to the formation of oxides than is that of iron or steel. Now the oxides that gradually form on the surfaces of metals are the main cause of the increasing resistance of unsoldered joints. When metal surfaces are perfectly clean the resistance of a tight joint between them can be lowered but little by the use of solder, but the solder prevents the formation of oxides in the jointed surfaces. It is well known that any iron or steel surface to which damp air has access soon becomes coated with oxide, and this result can hardly be avoided in the hundreds and thousands of contacts between electrical fittings and the hull of a ship, when the latter is used for the return circuit. The result is that a resistance at these joints, which may be trifling when the fittings are first erected, is apt to become quite a serious matter at the end of five or ten years. The hull of a ship, made up with a great number of steel plates, obviously has many joints which an electric current flowing between distant points on the ship must cross. These joints between ship plates are, perhaps, less subject to corrosion than are those between electrical fittings and the hull, but there must be some action of this kind, and the scale on the plate when they are at first joined is rather a poor electrical conductor. Considering both the joints between electrical fixtures and the hull, and also those between the hull plates, it seems practically certain that whatever the resistance of a return circuit through the hull when the ship is new this resistance will gradually increase and ultimately reach a very material amount. The resistance of a well designed two-wire system for a ship plant is in any case small, and it is at least doubtful whether the ship's hull and the connections thereto would, after a term of years, have a less resistance than one side or half of a proper two-wire system. At a time when electric plants on board ship were quite small and performed no service apart from lighting, the hull was more apt to give satisfactory results as a return circuit than now, when many hundreds of amperes flow from one part of the ship to others for the operation of lamps, motors and heaters.

Considering the factors of mechanical strength, ampere carrying capacity, and the uncertain and increasing resistance of joints, it seems impracticable to reduce the wires of a one-wire system below the sizes that would be used in the corresponding half of a two-wire plant. If the same sizes of wire are used in the two systems for a given case, the one-wire plant will require just one-half the weight of conductors necessary for the two-wire. Some labor will no doubt be saved in the one-wire plant, but its amount will not be so great as might be supposed, since twin-wire cable is not much harder to erect than a single wire, and the labor involved to secure proper attachments to the steel plates of the ship's hull cannot be neglected.

The cost of a wiring equipment on board ship must depend on a number of factors peculiar to each case, important among which are the loss of pressure permitted in conductors and the size of the ship. Allowing for the use of the same sizes of conductors in both systems, however, the total saving of labor and material by the one-wire plan will probably not exceed one dollar per lamp (16-candle power) capacity of the plant for an average case. To offset this rather small saving of first cost for the one-wire plan, it has a few decided disadvantages. Whether electrolysis at the joints between the steel plates of a ship's hull will ever become of importance is as yet an open question, but a practical demonstration of such effects on the hull of a ship may prove an expensive lesson. That heavy electric currents can work great damage when passing out of iron surfaces where moisture is present, and that with little warning until destruction is nearly completed, now has been fully demonstrated to the dissatisfaction of water and gas companies in many parts of the country.

It sometimes happens that the terminals of a fuse become short circuited or joined through a burnout, or that an arc continues between fuse terminals after the fuse has been melted by a heavy short circuit at some point on the line which it protects. In a two-wire system either of these mishaps is usually cared for by the fuse on the other wire, since double pole fuses are regularly used on two-wire work. In the one-wire plant there is no duplicate fuse to blow and open the connection, so a fuse designed to protect some larger wire must either blow out or else the wire which the faulty fuse connection was designed to protect must melt and thus produce a very real danger of fire. The known nature of an electric current is to expend the most of its energy in the generation of heat at those points in its circuit where the resistance to its flow is the greatest. This is illustrated by the incandescent lamp, which consumes most of the energy of the current flowing through it simply because its resistance is usually many times that of the wiring to which it is attached. As the joints between the electrical fittings and the steel hull of the ship grow old some of them are apt to develop a high electrical resistance through being loose or rusted, and such loose joints may become a serious danger as fire risks, because of their development of heat, against which no fuse on the circuit can guard.

In a two-wire plant one-half of the total electric pressure acts, under normal conditions, to break down the insulation of either wire or pole, while in a one-wire system, with a hull return, the entire effort of the pressure is to pierce the insulation at the single wire pole. For equal security against this effect alone, therefore,

the insulation of a single wire system should be of double thickness. It is regular practice in the erection of two-wire plants to install at the switchboard a device that will indicate at once when an accidental ground, or, in the case of ships, iron connection, occurs in any part of the electric circuit, so that it may be removed. As a one-wire circuit with hull return is in direct contact with the iron of the ship at a great number of points, an accidental contact in any place cannot be indicated at the switchboard, but is revealed only by the injurious effects it produces locally in the way of heat or fire at the place where it occurs. A very heavy iron connection might take so much current that the extra flow would be indicated by the amperemeter, but this cannot be relied on, as the load of amperes is constantly changing in any event. On a two-wire system a single ground or iron connection produces no flow of current or bad results whatever, until another ground or iron connection is made on the other side of the circuit, and there is usually opportunity to remove the first ground or iron connection before a second one can occur. With one-wire and a hull return there is damage at once when the first iron connection occurs, and no chance to remedy the faulty contact until the trouble happens.

Under ordinary conditions a contact with terminals of about 110 volts pressure gives but a slight shock to most persons, but with 220 volt circuits, which are now coming into use for lamps and motors, an unpleasant sensation can be had. It is seldom that the user of lamps and fittings on an insulated two-wire system is exposed to a shock, as he must make contact with both wires at some uncovered points simultaneously, but with the one-wire plant a hand laid on an iron part of the ship, while the other is in contact with the wire or a switch will result in a discharge of current through the body.

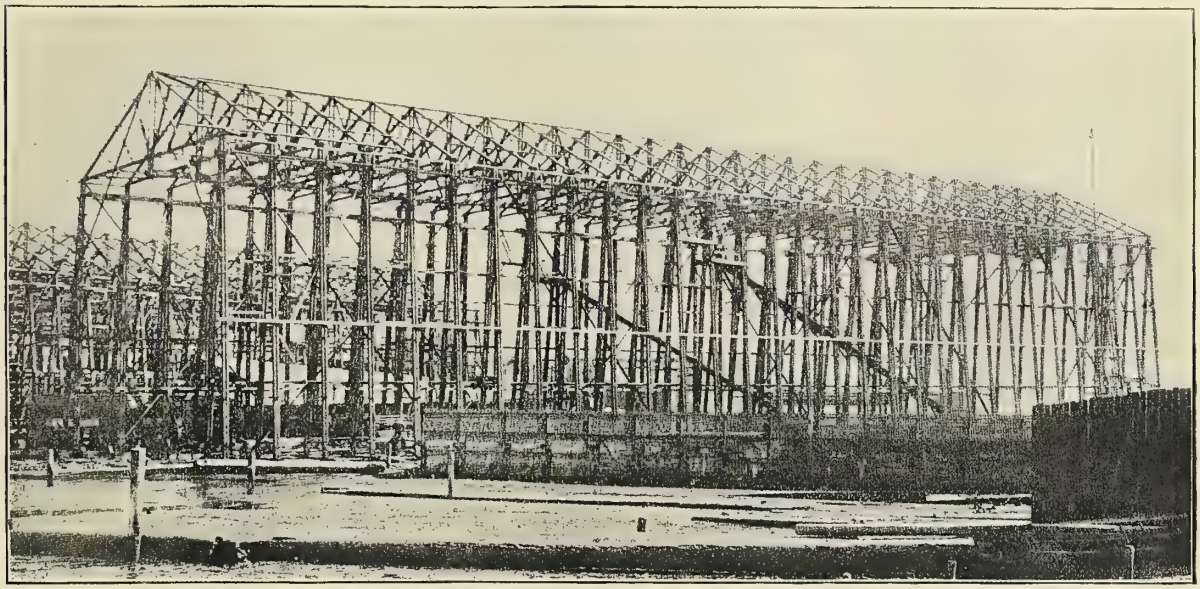
In face of these facts the preference that has grown up for two-wire insulated circuits on ships seems to be well founded.

OVERHEAD CRANES, STAGING AND RIVETER-CARRYING APPLIANCES IN THE SHIPYARD.*

BY JAMES DICKIE.

The need of some means whereby materials can be hoisted and deposited in any position on a vessel, while building, has long engaged the attention of the shipbuilder, and now that power-riveting is coming greatly into use, the demand for something overhead becomes imperative. Added to this is the staging necessary for the construction of the vessel, which is, of itself, a large item in the cost; while to this must be added the necessity of keeping the upper works fair while in the early stages of construction.

These four items form a large portion of the cost of the large merchantman or war vessel, either of the cruiser or battleship type, and when we take into account the enormous beam of these large vessels we find that anything done must be on a large scale. If, then, some kind of a structure that will facilitate the performance of these four functions can be made, we have at least advanced one step towards cheapening the cost of the modern vessel.

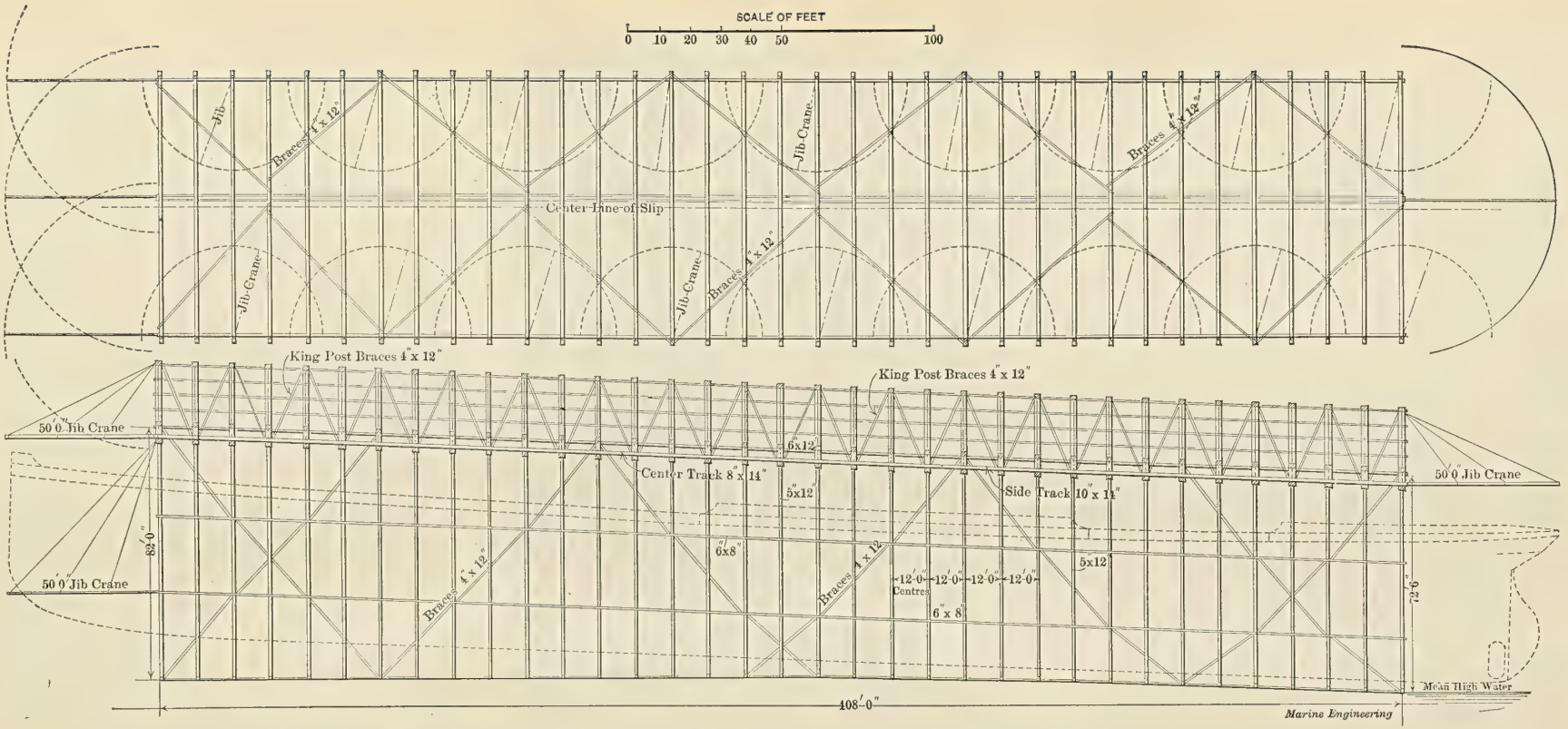


WOODEN FRAMEWORK OVER SLIP NO. 4 IN SHIPYARD OF UNION IRON WORKS, SAN FRANCISCO, CAL.

Previous to 1884, so far as the writer knows, the only means used to hoist materials on a vessel while building was the derrick-pole with the swinging-gaff. Since that time several forms of cranes have been adopted.

1st. We have the cantilever traveling crane, a good example of which is seen at Newport News. This crane has been so often described and illustrated that I need not do more than refer to it. It only performs one of the four functions sought, namely, the hoisting of materials, and as there is only one crane to two ships, the writer cannot see how it can do all the hoisting for one vessel, no matter how fast it travels, seeing that the time of hoisting and traveling is such a small part of the work. We find that the average hoist takes about 40 sec., traveling to the destination about 45 sec., while

*Read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York.



PLAN AND ELEVATION SHOWING STRUCTURAL MEMBERS OF THE FRAMEWORK OVER SLIP NO. 4 AT THE SHIPYARD OF THE UNION IRON WORKS, SAN FRANCISCO, CAL.

it takes from 7 to 12 min. to get sufficient bolts in a shell-plate or beam to enable the crane to be let go. At the Union Iron Works we often have to run half an hour to an hour in the evening (with two cranes to one ship) to get all the materials in place.

2d. The overhead crane or gantry, so much used on the lakes, which travels all over the vessel, with rails on the ground on each side. As all the vessels on the lakes are built broadside to the water, two cranes can be used to hoist the material for one vessel, and simply moved to the end when the vessel is launched; but they can only do the hoisting.

3d. The large gantry at Belfast, lately constructed, and used in the building of the *Oceanic*. The writer has seen all the others in operation, but has not seen this one. It appears to perform two of the functions sought, namely, hoisting and carrying riveters; but, judging from the cuts of it, it must be somewhat limited in its operation, as it cannot cover more than 120 to 150 ft. in length of the vessel at the same time, which appears to be insufficient, while such a large and heavy crane must be slow in its motion.

4th. The framework which covers the entire vessel while building. Of this form we have two examples, namely, those at Swan & Hunter's yard, on the Tyne, and those at the Union Iron Works in San Francisco. As both of these perform the four functions, although slightly different in detail, a description of one will be sufficient. The writer, having superintended the construction of those at the Union Iron Works, is thoroughly familiar with all the details, and thought that the publication of them might be interesting to the members of this Society.

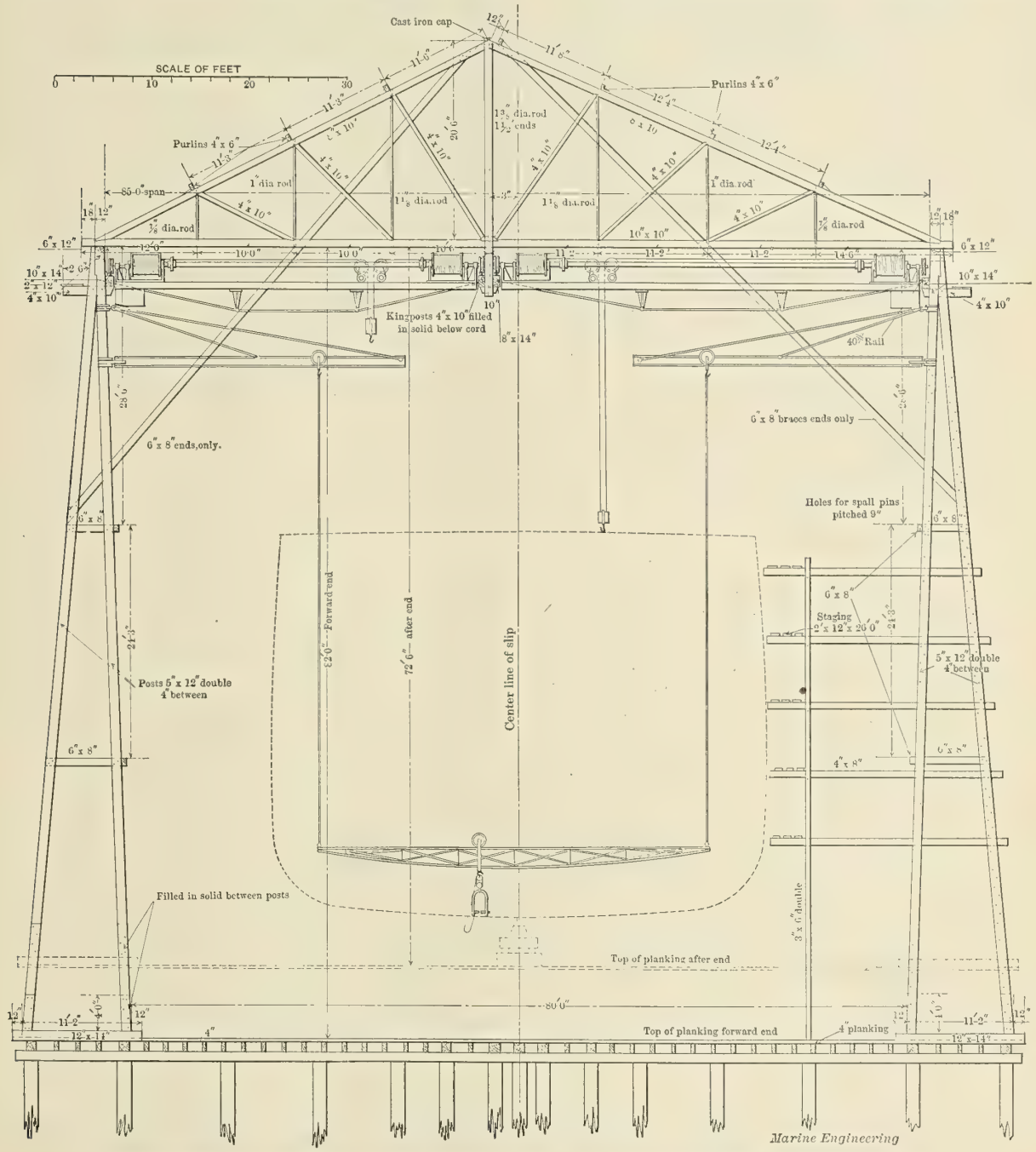
No. 1 was built, in 1884, of timber, as are all the others. It is 300 ft. long, 48 ft. wide, with an average height of 55 ft.; the top being built at an angle of 1 in 24, sloping towards the water. At the lower end is fitted a swing crane 35 ft. long.

No. 2, built in 1887, is also 300 ft. long 85 ft. wide and 58 ft. high, with a swing crane 40 ft. long at each end.

No. 3, built in 1891, is 300 ft. long, 85 ft. wide, 61 ft. high with a swing crane 45 ft. long at each end.

Slip No. 4 is covered with a framework similar to the others, but larger; being 408 ft. long, 85 ft. wide, the height being sufficient to cover the largest vessel. The apex of the roof is 3 ft. from the center, making one crane 6 ft. longer than the other. This is done to enable pieces such as beams, etc., to be landed on the center line.

The cranes are electric and travel at the rate of 180 ft. per min., fore and aft, 90 ft. crosswise, and the



CROSS SECTION OF WOODEN FRAMEWORK OVER SLIP NO. 4 AT UNION IRON WORKS, SAN FRANCISCO, CAL.

average height 78 ft. It was at first intended to make the structure of steel, but owing to the present high price and scarcity of material, it was decided to make it, like the others, of wood. There is a crane at each end 50 ft. long, thus covering a vessel 500 ft. long; and should longer vessels be built in it it can be easily lengthened, hoist 90 ft. per min., with a lifting capacity of 5 tons. A manila rope is used for hoisting, which gives considerable elasticity, and enables a plate to be bolted up if within an inch or two of the place. For plating under the bottom and under the counter we use a wire rope, rove through the plate and the corresponding hole in

the frame and toggled under the plate, which enables the plate to be drawn close up to its place.

One feature of the structure is the facility with which staging can be erected. Where the ship is large, the spauls, which are 4 by 8 in., are rove through the main posts and held by loose bolts at the ends. Where the vessel is narrower, a standard made of 3 by 6 in. double is set on top of the ground, and held from canting by the rigidity of the spaul in the posts, thus saving all bracing. As the posts are all 12 ft. centers, we use 2 by 12 in. by 26 ft. plank for staging, which we find strong enough for any work, and light enough to be easily handled.

We propose, in our new slips, to fit up cranes for riveting as shown in the section. These cranes are made of 8 in. T-bulb beam, and supported by two suspension rods. The trolley for the riveter runs on the lower flange of the beam; the wheels being 20 in. dia. makes it very easily moved.

The machines we are at present using are the toggle-jointed air machines, which drive 7-8 in. rivets with a 30 in. gap. The weight of the machine is about 1,400 lbs. It moves so easily that the operator has no difficulty in making the nicest adjustment. We are also using the percussion air machine, with a 4 or 6 ft. gap, which weighs only about 250 lbs. The cranes for riveting are only 32 ft. long, with a beam hung from them. This enables us to do hoisting and riveting at the same time, as all the material is hoisted up over the vessel and carried along near the center line to a point opposite to where it is to be landed. This center cross beam can be raised or lowered to suit the work on the vessel. When working on the inner bottom it will be down as shown; when on deck it will be close up to the cranes.

We have studied all the various overhead cranes and claim for this structure that it is no more expensive in first cost and fiulfills more functions than any other, except that of Messrs. Swan & Hunter, on the Tyne, and in comparison with it I think we have the advantage in staging. We find no disadvantage in having the posts as close as 12 ft., all the hoisting being done at the upper end, then carried over the vessel to the required place, and, when there, lowered into its proper place. As we use no side shores above the bilge, the top sides are always clear for lowering a shell plate into position, and, as I said before, the bottom plates and plates under the counter are hoisted from the ground with a wire rope rove through the corresponding hole in the frame, and toggled outside the plate; thus the entire plating can be put on the vessel with these cranes. We have two cranes at the upper end of the structure. These we use for frame riveting and all other pieces that can be riveted before going on board. As mentioned before, we use this structure to keep the upper works of the vessel fair while in the early stages.

Looking at the plan you will notice a large amount of lateral bracing on the lower member of the roof trusses, which makes the structure quite rigid.

Two Russian admirals and a number of other Russian officers of high rank are reported to have been arrested at Sebastopol on account of financial irregularities in the construction department at the dockyard there.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATÉRIEL.—IV.*

BY ENGINEER-IN-CHIEF GEORGE W. MELVILLE, U. S. N.

The war with Spain was too short to give a chance for great experience in any line, but the work of the *Oregon* stands out as a brilliant illustration of the fact that the modern battleship is not only the creature of the engineer, but is absolutely dependent upon him for success. You all know the story of Milligan's work as the chief engineer of the *Oregon;* of his ceaseless vigilance to keep everything in order and prevent any deterioration; of how he saved the good coal for the day of battle which finally came (though he was told it never could come), and, above all, how he persuaded Clark, the commanding officer, to have *all* the boilers ready all the time, although others had steam on only half the boilers, and, where it could be done, half the engine power was laid off. I am firmly convinced that the brilliancy of the victory at Santiago is largely due to Milligan's skill and foresight, and, as I said, this case is direct proof that however admirable as a great fighting machine, the battleship is useless except in the hands of trained engineers.

During the last fifteen years naval engineering has shared in the general progress of all marine engineering, and has led in many respects. Wrought iron, which was formerly the mainstay of the designer, has practically disappeared, to be succeeded by mild steel, which is not only stronger but much more reliable, and the manufacture and inspection of which has been brought almost to perfection. There is little doubt that the great improvements which have been made in both engines and boilers would have been impossible but for the greatly improved material. One of the greatest improvements has been in the reduction of weight of machinery, and this has been due both to improved material and to radical changes in design.

In the engine there has been a better disposition of the material; and the use of hollow instead of solid shafting and other large pieces of forged material, the use of steel castings, etc., has been instrumental in enabling the use of higher pressures, and particularly of higher rotative speeds. These rotative speeds have become possible since we have learned to design the propellers on rational principles. In the old days, as you are well aware, the rule was to make a propeller as large as possible, consistent with immersion, and this, on account of the empirical rules for the ratio of pitch to diameter, necessarily kept down engine speeds. Now we know that within reasonable limits we can design a propeller to suit almost any engine speed; consequently, we are left free to adopt as high a rotative speed as is desirable and consistent with safety, assured that we can afterward design an economical propeller to fit it.

In the boilers, the reduction of weight has been due, apart from the more recent adoption of the water tube type, to improved material, and especially to forced draft. This, as you are doubtless aware, is an Ameri-

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*President's address (1899) at New York meeting of American Society of Mechanical Engineers.

can invention almost contemporaneous with Fulton's early steamers; but it had almost disappeared, and after a brief revival under Isherwood during the civil war, had again died out until it was taken up in some of the foreign navies. At the present time no naval machinery is ever designed without the use of forced draft.

Pressures have been gradually rising, and even with shell boilers as high a pressure as 200 pounds has been employed; but with the present plans of using 250 pounds at the engine, with either triple or quadruple expansion, and some 25 or 50 pounds more at the boilers, nothing but the water tube boiler would do.

At the present time it seems as though we had practically reached the highest development possible with existing types of machinery for naval purposes, leaving the designer room only for greater perfection in details. We do not, of course, believe that finality has actually been reached, and it is possible that some radical change may take place which will give us a new type of machinery. Some of the more enthusiastic members of the profession think that the steam turbine is to be the successor of the present steam engine, and assuredly the performance of Parsons' *Turbinia* is sufficiently remarkable to justify the most careful study and further experiment. It is very interesting in this connection to know that in this country the development of the steam turbine is in the hands of one of our famous engineers, who is also one of the honorary members of this Society—George Westinghouse. He has been developing the steam turbine with special reference to its use in driving electric generators, and some of the results already obtained are very remarkable. With his characteristic energy and courage, he is not satisfied with results on a small scale, but is now getting out a steam turbine to develop about 2,000 horse-power on a single shaft, and when this has been built and thoroughly tested we shall be in a position to appreciate more thoroughly the bearing of this form of prime mover on naval engineering.

At the beginning of this address it was remarked that this was a peculiarly appropriate time for discussing the personnel of naval engineering, on account of the radical change which took place this year in the status of the engineer officers of our navy. For many years, as you all know, there had been an unfortunate controvery in our navy, known as the "line and staff fight," resulting from the fact that the line officers, as the older organization, were unwilling that the staff, and especially the engineers, should have all the rights to which the latter believed themselves, as naval officers, entitled. The great grievance of the engineers was that they held what was called "relative rank" and were denied the command of their men and a military title, so that there was always room for the statement, which unfortunately was made at times, that they were not really officers and had only a quasi rank. All men who have passed middle age have probably realized personally the difficulty of bringing about any radical change in existing conditions of long standing, and I really believe that the trouble in the navy was largely a matter of inertia. An enormous amount of valuable effort was wasted on both sides; the one to secure the coveted rights, the other to prevent this result; but matters had been shaping themselves for a considerable time so as to make a new state of affairs inevitable. The change in the means of offence on board ship had brought the line officer to the point of realizing that he must, of necessity, be a good deal of an engineer, and such work as the manufacture of guns, which is, of course, purely mechanical engineering, showed this very strongly. On the other hand, the work of the naval engineer on on board ship, which had originally been to direct a very few men with small machinery, has been gradually changing, until, on some of our large ships, the chief engineer commanded in fact, although not in name, about half the crew; consequently, his duties had become very largely executive and military, and thus of the same nature as the duties of the line officer. As a result of this state of affairs, many of the more liberal minds on both sides believed that the solution of the vexed question in the navy was the consolidation of the line and engineer corps, and making the new line officer an engineer as well as a sea warrior; or, as Congressman Foss expressed it, a "fighting engineer."

A board of naval officers, presided over by Colonel Roosevelt, then Assistant Secretary of the Navy, finally formulated a scheme for carrying out this idea of amalgamation, which was actually proposed in the board by a line officer (Captain Evans). When it was submitted to Congress, two members of the House Naval Committee, Hon. George E. Foss and Hon. A. G. Dayton, took up the measure very actively, and with the assistance of other members of the committee, pushed it forward to complete success, until the Personnel Bill became a law, March 3, 1899.

Under the provisions of this law the officers of the Engineer Corps were transferred to the line and given new commissions as line officers with *actual* rank, thus effectually disposing of the phantom of *relative* rank. I wish particularly to emphasize the fact that the basis of the law, and the consideration that led to its adoption, was the demonstrated fact that to have a successful navy every line officer must be a thorough engineer. This was very well phrased by Colonel Roosevelt in his report of the findings of the Personnel Board, where he said, "every officer on a modern war vessel whether he wants to or not, must in reality be an engineer." Mr. Foss, in his report to the House recommending the passage of the bill, used language of the same import, and elaborated the matter still further, and in the speeches on the floor of the House this was the subject which had most weight, and which brought about the passage of the measure.

A natural inquiry on your part will be, how successful is this measure in actual practice? To this the answer is that any such change must, of necessity, require time, and it is too early yet to speak of results. I wish, however, to put on record my opinion that if the administrative details necessary to carry the law into effect are worked out with an honest desire to give due effect to its plain intent, and with a desire to make it a success, the results will be all that can be wished, and we shall have the most efficient navy in the world. If, through any unfortunate combination of circumstances, which, however, I can hardly believe possible, there should be any temporary indif-

ference or opposition on the part of those in authority, the result can only be lack of efficiency and disaster in case of war until the intent of the Personnel Board and Congress is put into working effect.

It may occur to some who have only looked into the matter hastily that this scheme of amalgamation is contrary to the spirit of the age, with its tendency toward specialization; but, as an actual fact, the reverse is true. The misapprehension comes from a failure to thoroughly consider the case. When it is proposed to make every naval officer an engineer, we mean an engineer specially fitted for the work to be done in the navy, just as the other training of the line officer is for the duties which come specially to him; in other words, this new line officer—the "fighting engineer"—is to be a specialist in the very best sense of the term; that is, a man who has been specially and thoroughly trained for the work he has to do.

I think we may all feel a pardonable pride in this change in the status of our naval engineers. The amalgamation is analogous to that which occurred in the British navy just after Cromwell's time, and the analogy is not a fanciful nor forced one, but is strictly accurate. Up to the time of that change, naval vessels were manned by soldiers who did the actual hand-to-hand fighting, but were entirely ignorant of seamanship and another set of men who managed the propulsive power of the vessel, which was then the wind acting on the sails, and who directed the movements of the vessel. These men had no military rank, and were designated simply by professional titles, being known as "the sailing-master and his mates." The amalgamation which then occurred was of the soldier and the sailor, and out of this amalgamation was evolved the man-of-warsman and the naval officer. With the advent of mastless ships, we had reached an analogous condition where one set of people fought the guns and another set managed the propulsive power, this time steam acting through machinery. The new amalgamation has made a new naval officer, "the fighting engineer," to be followed in time by the successor to the old man-of-warsman, who will be the "fighting mechanic." The basis of the new amalgamation is the fact that in this industrial age engineering and mechanical skill are the source of efficiency in our navy, and this, as I have said, is a pardonable cause of pride to all of us as engineers.

In the past, engineering has been hampered at times in our navy on acount of the subordinate position which its representatives held in the naval organization; but in the future, as the whole body of naval officers will be engineers, we have every reason to anticipate an era of progress and efficiency greater than has ever been known in the history of navies.

This address has grown to a length which I hardly anticipated when I began, and for which I ask your indulgence, trusting you will agree with me that the importance of the subject and the opportunities of the occasion excuse the extent of the address. We of the old school have lived to see our fondest hopes realized in the proper recognition of our beloved profession before we have actually ceased to participate in its active work. We linger with fond memory over our trials and discouragements, as well as our successes, and we may, perhaps, realize that some of our successes have been due to the stimulus of opposition; nevertheless, it does not make for success that when one is honestly doing his best work he should feel that much of it may be in vain on account of senseless opposition and failure on the part of those in high places to appreciate it and as we older men leave the scene of action and pass on our work to the younger generation, we can congratulate them heartily on starting out under circumstances which are so infinitely better than those of our time, and which give them so much greater opportunity for highly efficient work for the republic.

New Pacific Coast Shipyard.

Another great shipbuilding plant is to be established at the Potrero, San Francisco, within a few hundred yards of the yard of the famous Union Iron Works. It is announced that the new yard will be fully as large, and as well equipped, as any on the Pacific coast, and it is the expressed intention of the promoters of the enterprise to enter in competition for warships and bids on some of the new vessels that will be ordered under the Naval Appropriation bill. The Risdon Iron and Locomotive works of San Francisco is the prime mover in the establishing of this plant, but it is reported that some local capitalist with a standing, such as John D. Spreckles or Claus Spreckles, is interested with the present stockholders.

The Risdon company has at present a large plant, at the corner of Howard and Beale streets in San Francisco, where it turns out mining and marine machinery. The corporation has frequently contemplated going into the business of shipbuilding, but the cost of building material and active competition of local shipyards prevented an investment in water front property. Recently, however, conditions have changed. Every shipyard on the coast has been busy. Orders have even been refused, and, as an additional incentive to prospective investors in shipbuilding plants, the railroad companies have made concessions in the matter of freights that have made it possible for the coast shipbuilders to compete with eastern firms.

President W. H. Taylor, of the Risdon works, is said to have been responsible for the origination of the present scheme to enlarge the field of operation. Several difficult problems confronted him when he first broached the subject to the stockholders, and principal among these was the inability of the corporation to secure a site for the proposed yard, at a point near the San Francisco water front, where extensive dredging would not be necessary for a basin.

The old Hunter's Point Drydock site was taken into consideration, but it was found that it would be impossible to acquire this property, as the Drydock company had reported progress in business and had finally decided to put in a new dock, much larger and more modern than the one now in use. About this time the Pacific Rolling Mills, an extensive concern controlling a fine water front site in South San Francisco, went out of existence as a working concern. Cost of labor on the coast and eastern competition—aided by cheaper labor and much cheaper fuel and raw material—made the output of the rolling mills very difficult to turn out

with profit to the company. The men were finally discharged and the works closed. Shortly afterwards, it is reported, the Risdon company secured an option on the property. Recently, it was turned over to them, but the price paid for it has been kept a secret.

The Pacific Rolling Mills are situated at South San Francisco on the Potrero Point, a splendid site covering thirty-five acres of ground, and controlling a water frontage of 17,000 ft. There is much valuable machinery already on the ground. A large drydock will be built and all necessary machinery of the most improved types will be purchased. Work may commence on the new yard July next, but the management of the Risdon Works is not as yet prepared to make any definite statement on this subject.

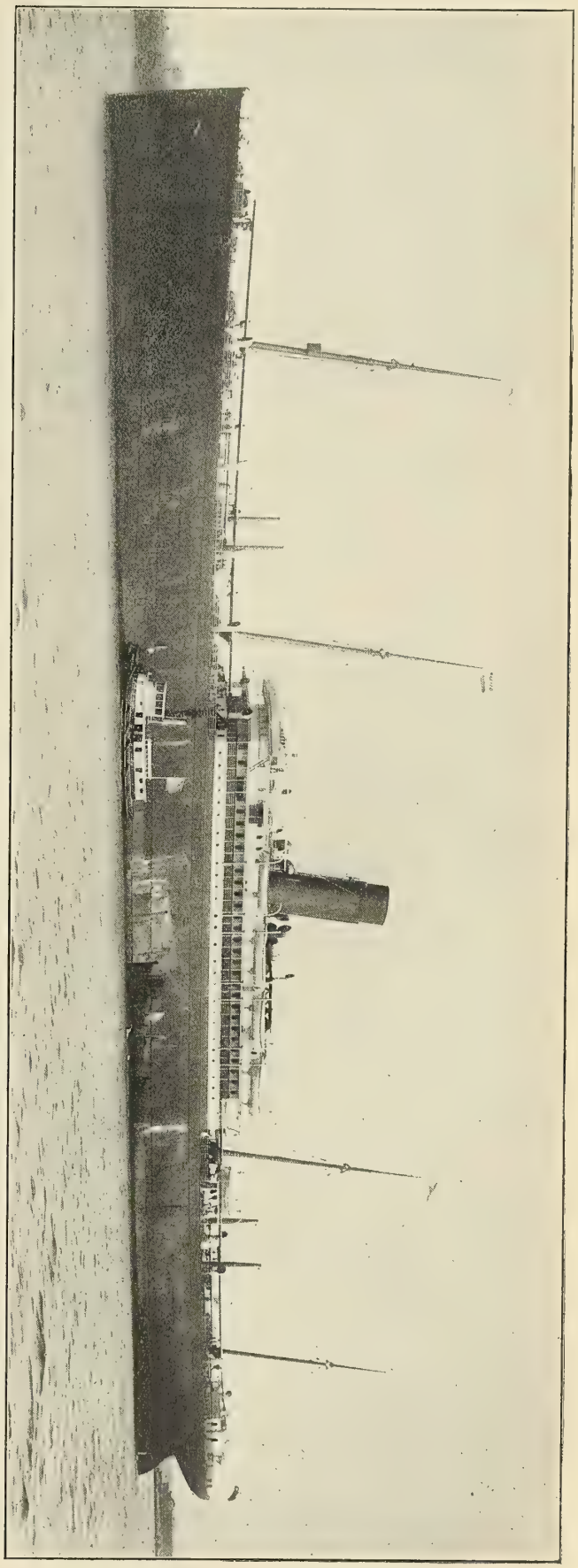
Atlantic Transport Liner Minneapolis.

Another of the modern leviathans of the deep arrived in New York harbor last month on her initial ocean voyage. The vessel was the *Minneapolis*, of the Atlantic Transport Line, in ballast from the yard of the builders, Harland & Wolff, Belfast, Ireland. She is, we believe, the third largest vessel now flying the British flag, those of greater tonnage being the mail steamer *Oceanic*, of the White Star Line, and the intermediate steamship *Ivernia*, of the Cunard Line. The latter vessel, described in our issue of February last, completed her maiden trip to New York last month, a few days after the *Minneapolis* had sailed for London.

The *Minneapolis* is one of four ships of like dimensions ordered for the Atlantic Transport service, the other vessels being the *Minnehaha*, *Minnetonka* and the *Minnewaska*. She is of the following dimensions: Length between perpendiculars, 600 ft.; beam, 65 ft.; depth, 44 ft.; gross tonnage, 13,401 tons; net tonnage, 8,651 tons. Though her dimensions are greater than those of the *Ivernia* her tonnage is slightly less.

The *Minneapolis* is of the same general type of vessel as the *Cymric*, of the White Star Line, or the *Pennsylvania*, of the Hamburg-American Line, all three vessels being products of the same yard. She has the usual long bridge structure amidships, in which all the living quarters and passenger accommodations are placed. Only one class of passengers is carried; there being accommodations for 228 first cabin.

The twin screws are driven by quadruple expansion engines, with cylinders 30 in., 43 in., 63 in. and 89 in., by 60 in. stroke, of the regular Harland & Wolff pattern. Steam is supplied at 214 lb. pressure, and the designed I. H. P. is 10,000. A trial speed of 17 knots was reported. There are five steel decks and as many collision bulkheads. In addition to the cargo space there is accommodation under the shelter deck for about 800 head of live stock. When loaded ready for her return voyage the *Minneapolis* drew nearly 32 ft. of water.



ATLANTIC TRANSPORT LINE TWIN SCREW CARGO AND PASSENGER S. S. MINNEAPOLIS, PHOTOGRAPHED ON HER ARRIVAL AT NEW YORK ON HER FIRST TRIP OUT.

WAGES PAID MECHANICS IN THE PRIVATE SHIPYARDS OF FOREIGN NATIONS.

In considering questions of vessel construction from a competition standpoint the prevailing rate of wages paid in private yards of the various shipbuilding nations is of much importance. So far as material is concerned our own yards had an advantage over those of foreign countries before the recent "boom" sent structural steel away up, and for a time, at least, brought back the old conditions. The advance, however, is not likely to be permanent, and when the rush is over prices will undoubtedly fall.

This question of wages in shipyards has been in part the subject of an extensive investigation by the U. S. consuls abroad under instructions from the Department of State at Washington. Their several responses have been embodied in a special consular report on the "Merchant Marine of Foreign Countries," just issued. The queries were addressed to the consular officers of the United States, the chief purpose being to procure accurate information concerning the carrying trade of each maritime country. Among the inquiries was one asking what was the average weekly wages of men engaged in the various construction branches in shipyards, a list of occupations being given. For this reason the information secured is in most cases confined to a limited number of trades or occupations. Probably very few of the consuls have much familiarity with ship construction, and so, in making inquiries, they did not go beyond the letter of the instructions, and for these reasons the information is not as complete as might be the case had the investigation been conducted by experts. What there is, however, is accurate and authoritative and of very great value. In the accompanying table we have gathered together the figures for the various countries, which are scattered throughout the report, so that they admit of more ready comparison. In many cases it will be possible to supply omissions by estimate, a sufficient number of different occupations being covered to give a line on the situation in general.

It will be noted in reading the table that not all of the returns give the average *weekly* wages, in some cases the rate by the *hour* and by the *day* being given.

Besides the figures in tabular form the various reports contain memoranda which are helpful to a proper interpretation of the figures, and in some cases are worthy of careful reading by manufacturers of shipbuilding materials, fittings and apparatus of various sorts.

TABLE SHOWING AVERAGE WAGES PAID WORKMEN IN THE PRIVATE SHIPYARDS OF

Country	Rate of Wages	Blacksmith	Boiler Makers	Cabinet Makers	Calkers	Coppersmiths	Drillers	Fitters	Furnacemen	Joiners	Laborers
AUSTRIA—											
Trieste	Dollars per week								4.87—6.09	4.06—4.87	2.84—3.65
CANADA—											
Toronto	Dollars per day								1.75	2.00	1.00—1.25
Halifax	Dollars per day									2.25	1.25—1.50
DENMARK—											
Copenhagen	Dollars per week					10.18—10.72					
*FRANCE—											
La Seyne	Cents per hour								17.37	11.58	8.69—10.52
GERMANY—											
Bremen	Dollars per day		.87		.85		.70		.78		
Stettin	Dollars per day		.75—1.25		.60—.80		.75—1.00		.75—1.00		.60—.70
Hamburg	Dollars per week								7.14	9.52	3.33—6.66
Kiel	Cents per hour								8—9	9	6—7
**ITALY—	Dollars per week								6.00—14.50	5.00—7.00	2.50—3.50
†JAPAN—											
Nagasaki	Cents per day		75			62.5		75	35		25
††NETHERLANDS—											
Amsterdam	Cents per hour									8.8	6.4—6.8
UNITED KINGDOM—											
§Barrow-in-Furness	Dollars per week								6.32	9.30	4.38—5.83
Belfast	Dollars per week								10.94	8.76	4.38—5.11
Glasgow	Cents per hour		18	17—19				16		17	11
Glasgow	Dollars per day										
‖‖Glasgow	Dollars per week	6.56									
Liverpool	Dollars per week								5.59	9.11	4.86
¶London	Dollars per week								6.08	9.61	4.38—5.82

* At Marseilles the average wage per day is 96 cents to $1.35, depending more on individual merit than on the trade. Laborers receive from 57 cents to 67 cents per day. The French working day is ten hours.
** Wages are less in Central and Southern Italy than in the North. † Productive capacity of workmen is very low.
†† On work given out on contract, the workmen receive on the average 20 per cent higher wages.

Austria—The consul at Trieste writes that the principal materials used in shipbuilding are produced in Austria, but considerable quantities of metal have been imported during the past few years, and these imports are on the increase. A few mechanical accessories are almost exclusively imported from England. The current price of Austrian steel ship plates is 100 to 110 florins ($40.60 to $44.66) per 1,000 kilograms (2,204.6 lb.). Bounties are granted by the state for the construction of both sailing ships and steam vessels, and by a recent law all ships are exempted from taxation for another five years.

Belgium—At Antwerp work is let out by job or piece work, by contract, wages varying from 15 cents for boy apprentices to $1.25 a day for workmen. Little new work is done, and all structural steel used is of domestic manufacture.

Canada—Vessel construction has fallen off enormously since the substitution of metal for wood. In the year 1868, one year after confederation, Canada built a total of 87,230 tons of new ships, and last year less than one-quarter of this tonnage was put out. In 1876 Canada built ships for other countries of the value of $2,189,270, while last year her output for foreign owners amounted to only $191,069. In his report the Consul General at Montreal says that Canadian steel making interests are likely to reach gigantic proportions during the next ten years, and there are indications that shipbuilding will develop simultaneously with the iron industry. Present movements in this direction cited are the establishment of a steel shipbuilding plant at Hamilton, the increase of present facilities at Toronto, the construction of a dry dock and preparations for a yard also at St. John, N. B., and the plans of the Dominion Iron & Steel Co. at Cape Breton, which contemplate the establishment of an extensive plant at a future date. No bounties to assist shipbuilding are granted in Canada, but on steel billets and bar and pig iron there is a bounty which is indirectly of aid to shipbuilders. At present all steel plates and shapes are imported, the bulk formerly from Pennsylvania at 2 1-4 cents a pound F. O. B. cars at the mill. Now English ship plates are delivered in Canada for $2.12 1-2 per 100 lb.; 5-16 in. plate, $2.16 1-2 per 100 lb.; 1-4 in. plate, $2.20 per 100 lb., and shapes $2.50 per 100 lb.

Denmark—Structural material for ships is imported from Germany, Great Britain and the United States. During 1899 the average price for steel plates was $35.23, cost, freight, and insurance, Copenhagen.

France—For a number of years the Government has given much attention to the merchant marine. By the act of 1893 the bounty for construction was placed at $12.54 per gross ton for vessels, and $2.89 1-2 per 220 lb. for machinery and boilers. Most of the French yards are so occupied with naval work that private owners have to wait a long time to get orders filled. Thus a vessel which could be delivered from an English yard in nine months would, in a French yard, take twenty or thirty months to build. The principal materials used in the construction of vessels are of domestic production, though due to the great demand for steel for other purposes and to the cheapness of certain classes of foreign shipbuilding material, the builders make extensive importations, chiefly from England. The price for ship steel at Havre is quoted at $58 per ton, and at Marseilles, $46.30 per ton. At the latter port the wages of shipyard mechanics range from 96 cents to $1.35 a day of ten hours, the rate depending more on individual skill than on the trade. Laborers get 57 cents to 67 cents a day. Overtime counts as time and a half to double time. In the Government dockyards at Toulon the men are divided into four classes, with wages ranging from 12 cents to $1.31 a day. After 25 years of service and 50 years of age an annual pension is granted, ranging from $102.29 to

FOREIGN NATIONS.—COMPILED FROM SPECIAL (OFFICIAL) REPORTS OF U. S. CONSULS.

Loftsmen	Machinists	Moulders (Brass.)	Moulders (Iron.)	Painters	Pattern Makers	Platers	Plumbers	Riggers	Riveters	Sheet Iron Workers	Ship Carpenters
.....	4.87—6.09	4.87—6.09	4.87—6.09	3.65—4.87	4.87 to 6.09	.....	4.06—4 87	4.47—5.68	6.09—7.31	4.87—6.09	4.87—6.09
.....	1.75—2.00	2.25	2.25	1.75	1.75—2.00	.....	2.00—2.50	2.00	1.90—2.00	1.75—1.90	1.75
.....	2.50 3.00	.....	2.00—2.25	2.00	....	.....	....	2.25—2.50	3.00	1.75—2.00	2.50
6.97	8.04—10.18	.....	8.04—8.58	12.32	8.58—10.18	.....	8.84- 9.65	8 84	8.30—8.86	9.11—9.63	.....
.....	11 58—12.55	.....	.....	11.58—15.44	17.37	.....	.....	15.44—17.37	13 51—15 44	13.51	14.48
.80	.85	.....	.83	.90	.71	.....	.73	.....	.85	.94	1.00
.....	.75—1.25	.....	.65—.85	.70—.85	.75—1 00	.....	.60—1.00	.....	.60—.80	.70—.85	.75—1.10
.....	12.37	6.66—7.14	6.66	8.57	16 66—19.04	.....	7.14	8.57	9.52—10.71	6.66	9.52
.....	.....	8—8.3	8—8.3	7—9	.....	.....	7—9	7	10	7—9	7—8
.....	12.00—16.00	5.00—18.00	5.00—18.00	.....	7 00—9.00	....	5.00—7.00	.....	5.00—9.60	5.50—14.00	.....
.....	75	.....	.....	37.5	65	.....	.....	50	.....	.....	60
.....	.....	.....	.....	7.2	8 8	.....	. .....	10	7.6	6.4—8	8.8—10
.....	.....	8.99—9.48	9.24—10.21	8 75	.....	.....	9.30	8.02	14.59—18.24	9.36	9.42
.....	8.76	8.76	9.73	8.70	8 76	.....	8.76	8.76	8.76	9.73	8.76
.....	.....	20	17.5	13.5—15	17	.....	20	.. ..	.....	.....	.....
.....	.....	.....	.....	.....	... .	.....	.....	.....	3.65—4.38	.....	.....
10 95	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	.....
.....	7.29	.....	.....	8.26	9.60	9.73—10.21	8.75	8.75	8 75	.....	9.48
.....	.....	9.37	8.62	8.27	9.73	.....	8.76	7.30	14.60—17.03	8.76—9.25	10.58

§ The week consists of 54 working hours. ||| The week consists of 54 working hours. Draughtsmen receive from $6.08 to $12.16 per week. Hull rivetting is usually sub-let in sections to one man who engages a "squad."
¶ Riveters are on piece work exclusively. Iron moulders on piece work earn about $14.60 per week.

$218.09, and an allowance for widows up to a maximum of $134.14 annually.

Germany—Merchant shipbuilding on an extensive scale dates only from the late eighties. Since 1891 the Government has paid about $2,380,000 as premiums for new ships built, and has for several years granted heavy subsidies to mail steamship lines, and in many other ways has helped build up the German merchant marine. Shipbuilding materials can be imported duty free, and materials of domestic origin are hauled from the manufacturers to the shipyards, by the Government railroads, at the bare cost of handling and transportation.

Italy—Navigation subsidies and construction bounties are paid by the Government. The latter in amount are as follows: Iron and steel ships, $14.86 per ton gross, and wooden vessels, $3.38 per ton gross; engines, $2.41 per I. H. P.; boilers, $1.83 per quintal (220.46 lb.?). Structural material for ships is now manufactured in Italy, and only a small amount is imported. It is duty free. The price of steel plate is $4.63 to $5.40 per 220 lb., depending on the size of plate ordered. The consul at Naples reports that mechanics receive only 30 cents to 60 cents per day, though experts sometimes receive $1.00 a day.

Netherlands—The work of the Government in behalf of the merchant marine is almost entirely confined to police regulations. Payments are made only for the carriage of mails. Steel and iron for vessel construction are imported from England and Germany, present prices being $3.26 to $3.80 per 220 lb., but these prices are advancing. Work in shipyards, so far as possible, is let on contract.

United Kingdom—The British Government does not pursue any particular policy for the purpose of promoting its merchant marine. Subventions are paid for the use of certain vessels as armed cruisers in case of war, and payments are made for the carriage of mails. Practically all structural material is of domestic manufacture, though some large steel castings are imported from Essen. Some of the wood working machinery in use in shipyards is made in the United States. The Consul General at London reports the price of steel delivered in the shipyards as $36.50 a ton for plates and $34.67 a ton for angle and bulb bars. In "depressed times" steel plates have been delivered as low as $23.11, and bars $21.90. The consul at Liverpool states that current prices for steel hull plates run from $37.71 to $41.97 per ton. Prices at Glasgow are given by the United States Consul as follows: Ship plates, $37.10 per ton; boiler plates, $42.58; angles, $35.28; hematite pig is quoted at $17.51 per ton, against $12.65 for the same period in the previous year.* Pine and cedar for decks is quoted at 8 cents to 12 cents a sq. ft., and mahogany for interior finish 12 cents to 26 cents a sq. ft. Teak wood averages 10 per cent higher. Interesting details of prices of vessels are given. The Cunarders, *Campania* and *Lucania*, 12,950 gross tons, cost about $2,435,683 each, but could not be built now for anything like that price. Two mail steamers for the Castle line, built at Fairfield, of 10,000 gross tons and 15,000 I. H. P., cost $1,459,950 each. "Other well appointed passenger steamers, with engines to drive them at from 12 1-2 knots to 15 1-2 knots, cost about $97.33 to $121.66 per ton; first-class river steamers cost from $136.26 to $160.59 per ton; coasting passenger and freight steamers from $72.99 to $107.06 per ton, and the usual tramp of from 4,000 to 6,000 tons, $37.71 to $51.09 per dead weight ton." Prices for war vessels run high, according to this schedule: Destroyers, $291.99 per ton; dispatch boats, $267.65 per ton; belted cruisers, $257.92 per ton, and first-class battleships, $243.32 per ton.

In the foregoing attention has been given to the data concerning construction, contained in the document, rather than to operation. In another chapter we hope to again refer to this side of the investigation as disclosed in the valuable consular reports. Prices of material are, of course, subject to fluctuation, and no doubt the figures given are not the market prices now. They permit of close comparisons, however, for all the reports were made out about the end of last year, so that while prices are probably less than those of today the differences between one country and another are probably no greater.

*British prices for material have advanced considerably in the past few months. Recent quotations are: Pig iron, $18.22 per ton; steel ship plates, $40.09 per ton; angles, $39.41 per ton; boiler plate, $46.78 per ton; steam coal, $4.61 to $4.86 per ton; small coal, $3.40 to $3.64 per ton; blast furnace coke, $6.07 per ton. War conditions have also advanced the price of labor.—ED. M. E.

FAILURE OF A WATER TUBE BOILER DUE TO SHORTNESS OF WATER.*

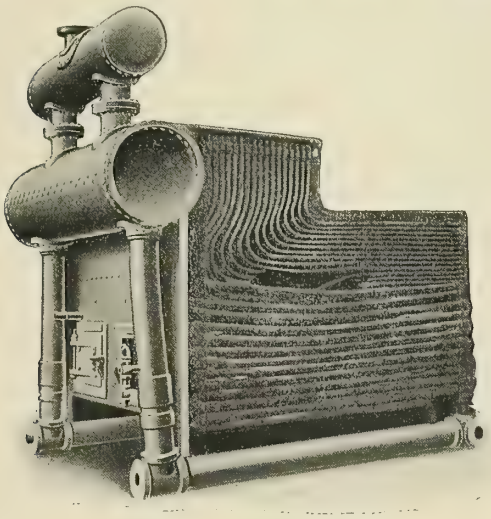
BY WILLIAM F. DURAND.

A few months ago there occurred to the boiler of a tug-boat in New York harbor a most remarkable accident, resulting in apparently melting out a large cavity in the midst of the nest of wrought-iron tubes. The boiler is of the Boyer[1] water tube type, and as shown in the figure consists of an upper drum extending transversely across the front of the boiler and connected by large down-flow pipes to a smaller transverse lower drum at the back. Extending vertically from the lower drum and horizontally from the upper drum are smaller tubes acting as headers, and joining these are the steam forming tubes in elements, each element consisting of a so-called "flat" of tubes connecting a pair of headers. The circulation of water in the boiler is from the upper drum where the feed enters, down through the down-flow pipes to the lower drum and then up through the vertical headers to the steam forming tubes. It then passes through these tubes to the upper horizontal drum where the steam and water are separated, the former passing to the engine and the latter falling to the lower part of the drum and joining the round of circulation again.

On the day of the accident the regular engineer of the boat was sick and was replaced by a substitute. It appears that the preceding night, according to his custom, the engineer had closed the water gauge cocks, thus shutting off the gauge from the boiler, and it would appear that this fact was unknown to, or overlooked by, the engineer of the day. The tug started out with a tow, and nothing at first seemed amiss, until meeting

*From the *Sibley Journal*, Cornell University, Ithaca, N. Y.
[1]For drawings of this type of boiler see March issue, page 125.

with head wind and rough water, complicated by the swell of a passing steamboat, it was found necessary to put on full power to make headway with the tow. The boiler pressure had been somewhat over 100 lb. per sq. in., and the steam jet at the base of the stack was put on. The steam pressure, however, continued to fall, and a suspicion seems to have arisen that something



BOILER WITH CASING REMOVED.

was wrong, though so far as observed the feed-pump had previously been in regular operation. The evidence here is scanty, but the engineer, from one reason or another, apparently became convinced that his water was short, and he therefore started in to haul the fire. He had hardly more than begun when he noticed something dropping down from above into the fire, and shortly after the steam pressure fell to nothing, but without explosion or violence so far as observed.

Subsequent examination showed a condition of affairs as indicated by the cut made from a photograph taken at the time, and after simply removing a side superheating coil the better to show the cavity burned out. Some 200 or more tubes were burned or completely melted out, leaving a clear cavity as shown, the metal formerly composing these tubes having simply melted and run down, mostly into the fire, occasioning the "dropping down" noted by the engineer, though small amounts remained attached to or clogged between the remaining ends of the burnt tubes. The substance thus found on and between the tubes has been kindly analyzed in the Department of Analytical Chemistry, Cornell University, with the result of showing a composition substantially identical with that of the magnetic oxide of iron (Fe_3O_4). To judge by its appearance this substance had plainly solidified from a state of fusion, and at the time of solidification, at least, seems therefore to have had the composition of magnetic oxide of iron rather than metallic iron.

The melting point of wrought iron has been variously estimated at from 3,000 to 4,000 deg. Fah., but in any event it is far above the temperature attainable in an ordinary coal fire, and far above any temperature possible by the heat radiated to the tubes at a distance of 10 to 15 in. above the fire. Furthermore it will be noted that the focus of the action seems to have been within the nest of tubes, the lower tubes next the fire being hardly more than melted through, while some 30 to 36 in. are melted out of those a little way above. There seems, therefore, to have been a development of heat in the midst of the nest of tubes of sufficient intensity to give a temperature of from 3,000 to 4,000 deg. Fah., and for a time sufficient to accomplish the melting of the tubes as shown. The puzzle to be explained is, therefore, the development of a source of heat of such an intensity.

The following are a series of suggestions which may have some bearing on the solution:

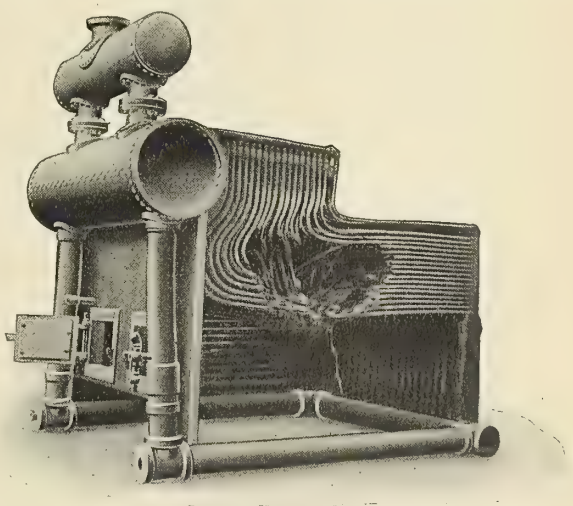
(1). The gauge glass was shut off from the boiler so that its reading had no meaning whatever, and there is no knowing what the level of the water in the boiler may have been at any time.

(2). The general conditions of the service of the boat at the given time indicate a heavy call for steam, and there is no assurance that the feed-pump made good to the boiler the draught of water from it.

(3). From (1) and (2), and entirely independently of the final result, we may assume the probability of low water in the boiler. Again, the absence of any explosion or violent outrush of steam at any time, at least so far as noted by the engineer, indicate that at the instant of rupture the water was just about down to the last drop, and that what small amount of steam may have been in the boiler at the instant the tubes melted was not sufficient to create any great amount of disturbance.

(4). With the low water would come overheating of the tubes, and we may well believe that most of them in the end would become red hot, or nearly so.

(5). The overheating of the tubes would occur while they were still under pressure, and it might naturally result that one or more overheated tubes under such pressure would open out in the welded joint, thus al-



CAVITY IN GENERATING TUBES.

lowing jets of steam to escape into the fire, or onto the fire side of the tubes.

(6). Red hot iron decomposes steam into hydrogen and oxygen, and joins with the oxygen, forming magnetic oxide of iron. Such a decomposition would, therefore, most naturally result under the circumstances sup-

posed to exist. In fact, such a decomposition might already have begun on the inside of the tubes, their temperature very probably having risen to the point where such action would occur.

(7). There may thus have arisen a series of conditions providing a source of hydrogen within the nest of tubes. If now there should come in an excess of air furnishing oxygen in abundance, the hydrogen might suddenly enter into combustion, furnishing practically an oxy-hydrogen flame in the midst of the nest of tubes. The heat thus developed would presumably be of sufficient intensity to accomplish the results noted.

(8). Again, magnetic oxide of iron melts and becomes fluid at a temperature considerably lower than wrought iron, and the first result might be the melting of the oxide previously formed, accompanied by the continued formation and melting of additional quantities. In fact, it seems not unlikely with the action distributed over so considerable a surface that the operation would consist largely of a rapid formation and melting of magnetic oxide, the molten oxide serving as a flux and helping perhaps to bring the iron to a state of fusion. This might explain why so much of the molten product was magnetic oxide rather than metallic iron. In fact, it would probably be very difficult to bring wrought iron into a state of fusion in the metallic state in the intimate presence of oxygen, and we may readily believe that most of the molten result was of the same character as that analyzed.

The combination of events here found—the complete melting of such a mass of wrought iron boiler tubes in the midst of the nest, with no explosion or noticeable disturbance—seems to mark this as an accident unique among boiler casualties. No blame, of course, can attach to the boiler either in point of design or workmanship. Boilers are not intended to work without water, and usually when an occasional attempt is made to operate them in this way the results are serious to life and limb as well as to the boiler itself.

New Lake Passenger Steamers.—A new steamship company for carrying on a fast freight and passenger service on the Great Lakes is projected. Buffalo, N. Y., parties are promoting the scheme, which contemplates a regular service between Buffalo, Cleveland, Detroit, Mackinac, Milwaukee and Chicago. To carry this into effect two combined passenger and freight steamers are to be constructed of these dimensions: Length on keel, 450 ft.; beam, 55 ft.; depth, moulded to main deck, 29 ft. They will be fitted with single screws, driven by triple expansion engines, to give a maximum service speed of 17 miles per hour. Each vessel is to have accommodations for 950 passengers, and is expected to be ready for service in May, 1901. The corporation is known as the Great Lakes Steamship Co., and has offices in the Guarantee Building, Buffalo, N. Y.

On Saturday, April 14, the Paris Exposition of 1900 was formally opened to the public by President Loubet of France. The United States exhibitors are more numerous than those of any other foreign nation, the total number of exhibitors being over 6,500. The United States exhibits cover nearly 330,000 sq. ft. in 47 separate exhibition spaces.

NEW 18,000 TON VESSELS FOR THE PACIFIC MAIL STEAMSHIP CO.

Work is progressing on the two magnificent steamers for the Pacific Mail fleet at the Newport News yard, and in a little more than a year from now, these boats will be ready to contest the transpacific records. These two ships are of the largest size, and will be capable of making a sustained sea speed of 18 knots. Not only indeed will they be the largest and finest vessels on any route in the Pacific trade, but in point of size and equipment they will be in the same class with the best ships in the transatlantic service. The new vessels will be put on between San Francisco and Hong Kong, with Honolulu, Yokohama and Nagasaki as ports of call.

Following are the dimensions of the new vessels: Length between perpendiculars, 550 ft.; length over all, 572 ft. 4 in.; beam, 63 ft.; depth, 40 ft.; draft, 27 ft.; displacement, about 18,600 tons. Accommodations will be provided for 200 first-cabin passengers, 30 white steerage and 1,200 Chinese. Quarters for the latter are arranged so that the space may be utilized for other purposes, if unoccupied by Chinese.

The hulls will be constructed of steel, with frames spaced 32 in. apart throughout. A double bottom extends from stem to stern and is carried up to the turn in the bilge. There are four decks extending the whole length of the vessels, known as the lower, main, upper and promenade decks. In addition to these are the orlop and boat decks.

Below the lower deck are located the orlop decks, engine and boiler rooms, coal bunkers, shaft alleys, chain lockers, trimming tanks and cargo space. Forward of the fire-rooms are water ballast tanks, and aft of the engine rooms, fresh-water tanks. On the lower deck are the store-rooms, cargo space and coal bunkers.

On the main deck are located store-rooms, quarters for white steerage and Chinese, baggage room, coal bunkers, dynamo room, ice machine and refrigerating rooms and the steward's quarters.

On the upper deck forward are seamen's and petty officers' quarters, wash and toilet rooms for Chinese and white steerage, carpenter's and paint shops and lamp room. On this deck are also situated the first-class dining saloon, pantry and galley, staterooms, passengers' toilet rooms, quarters for the engineer's force, freight clerks and electricians, and the donkey boiler in the boiler hatch. Aft are the firemen's quarters, crew's and steerage galleys and Chinese hospital.

The next deck is the promenade deck, on which is located the windlass forward. Amidship are first-class cabin accommodations, arranged in order: Social hall, music room staterooms, passengers' toilet and smoking rooms.

On the boat deck are situated the officers' quarters, armory, chart room and wheelhouse. Above this is the flying-bridge, on which there is a steering gear.

The main engines consist of two four-cylinder quadruple expansion engines of the vertical inverted, direct-acting type placed abreast of each other in separate water-tight compartments. The cylinders are of the following dimensions: H.P. 35 in., 1st I.P. 50 in., 2d I.P. 70 in., and L. P. 100 in dia. with a common stroke of 66 in. The engines are designed to develop 18,000 indicated

horse power, while running at 86 revolutions per minute. The cylinders are arranged in the following order: H.P. forward, L.P., 2d I.P., and 1st I.P. aft. The engine framing consists of cast steel columns of I section, secured to the cylinders and bedplates. The bedplates are also of cast steel. The valves are of the single ported piston type and are of cast iron. The link motion is the Stephenson link type. All the cylinders are steam jacketed. The piston rods are of forged steel fitted with cast iron crosshead slippers lined with Parson's white bronze, which work in cast iron crosshead guides. The connecting rods are of forged steel 138 in. long between center of crank and center of crosshead pin. The pistons are of cast steel and are of the dished pattern. The eccentrics are of cast iron keyed to the crank-shafts. The eccentric rods and valve stems are of forged steel, the former being secured to the eccentrics by composition straps. Each main engine will be fitted with a steam and hydraulic direct acting reversing engine and a 7 in. and 7 in. by 5 in. turning engine.

The thrust bearings will be two in number, of the ordinary horseshoe type, with fourteen shoes to each bearing. The stern tube bearings will be of the ordinary brass sleeve pattern, fitted with lignum vitæ.

The crank-shafts will be forged steel in four interchangeable sections. The thrust, line and propeller shafts will also be forged steel. All shafts will be hollow. From the stern tube stuffing-box to the propeller hub the propeller shafts will have sleeves of composition, to protect against the corrosive action of the sea water. The propellers will be of the three-blade type. The hubs being cast steel and the blades bronze.

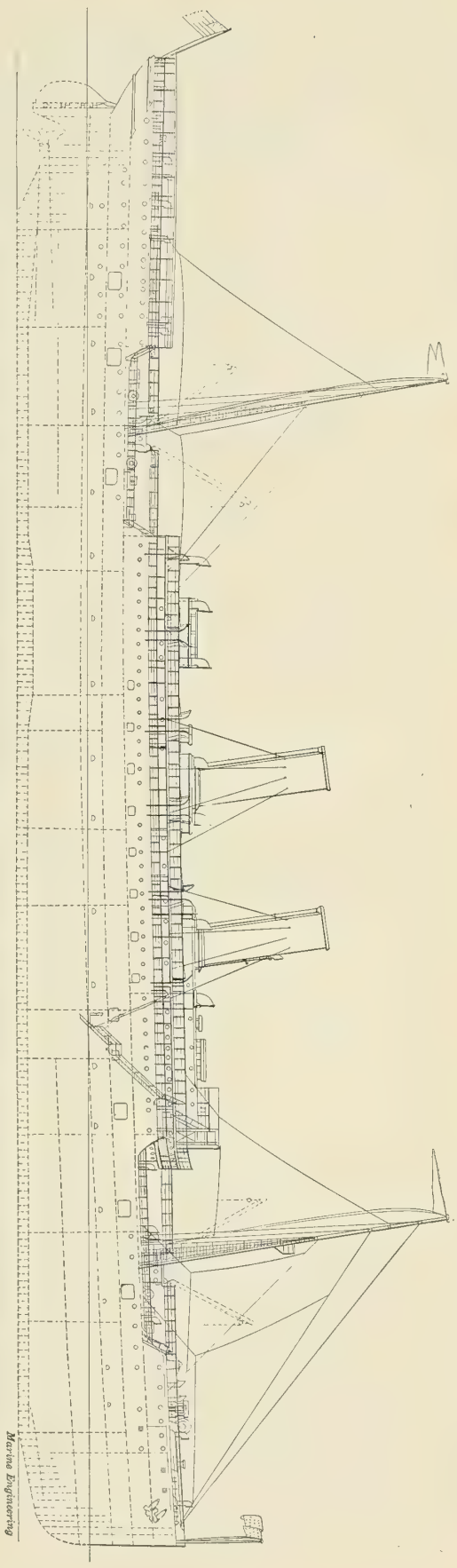
There will be two main condensers, one for each main engine. Each main condenser will have an independent air pump and two circulating pumps. The circulating pumps to be operated by a compound engine. Two auxiliary condensers will also be provided with combined air and circulating pumps attached. Two feed-water heaters will also be installed.

The boilers are to be nine in number, eight main boilers and one donkey boiler, of the horizontal return fire-tube type. The arrangement of boilers is as follows: One donkey boiler on the upper deck in the boiler hatch. The main boilers placed in a fore and aft direction in two compartments, with all fire-rooms athwartship. In the after boiler compartment two single-ended and three double-ended boilers, and in the forward boiler compartment three double-ended boilers. Following are the principal boiler dimensions:

	Auxiliary.	Main Boilers.	
	Boiler	Single Ended.	Double Ended.
Type	Scotch	Scotch	Scotch
Number	1	2	6
Dia. ext. mean	11 ft. 6 in.	16 ft.	16 ft.
Number of furnaces	2	4	8
Length of grates	6 ft.	5 ft. 9 in.	5 ft. 9 in.
Number of combustion chambers	1	4	8
Tubes outside dia.	2½ in.	2½ in.	2½ in.
Heating surface	1,421 sq ft.	3,208 sq ft.	6,416 sq ft.
Grate surface	44 sq. ft.	76.58 sq. ft.	153.16 sq. ft.
Ratio of H.S. to G S.	32.3	41.89	41.89
Steam pressure	200 lb.	200 lb.	200 lb.

The vessels will be equipped with forced draft. The air will be heated before entering the furnaces and will be supplied by thirteen steam-driven fans.

There will be the following steam pumps for feed and



PROFILE OF THE TWO 18,000 TON TWIN SCREW STEAMSHIPS BUILDING AT NEWPORT NEWS SHIPYARD FOR THE PACIFIC MAIL FLEET.

Marine Engineering

other purposes. Four main and auxiliary feed pumps, two fire and bilge pumps and two sanitary pumps.

Each vessel will be equipped with an extensive electric lighting plant, also a refrigerating apparatus for the purpose of making ice and to provide means for cold storage. There will also be a distilling apparatus of improved type and design.

In the deck department the steering gear will be steam. Forward there will be a steam windlass and located at most convenient points will be eight cargo winches.

Both the hulls and machinery of these vessels were designed by the builders, the Newport News Shipbuilding and Dry Dock Company and each vessel will cost about $2,000,000 complete.

SCHOONER RIGGED STEEL TOW BARGES FOR DEEP WATER TRADE.

For carrying bulk freight in Atlantic coast service, the tow barge is being more and more employed, owing to the cheapness of this mode of conveyance and the independence of weather conditions as compared with sailing craft. Many of the barges in service are superannuated sailing vessels, or in more than one instance steamers stripped of all their machinery, their fittings, and nearly all their accommodations. These are more or less makeshifts—having the merit chiefly of cheapness—though it is not an uncommon opinion that anything that will float when loaded is good enough to tow.

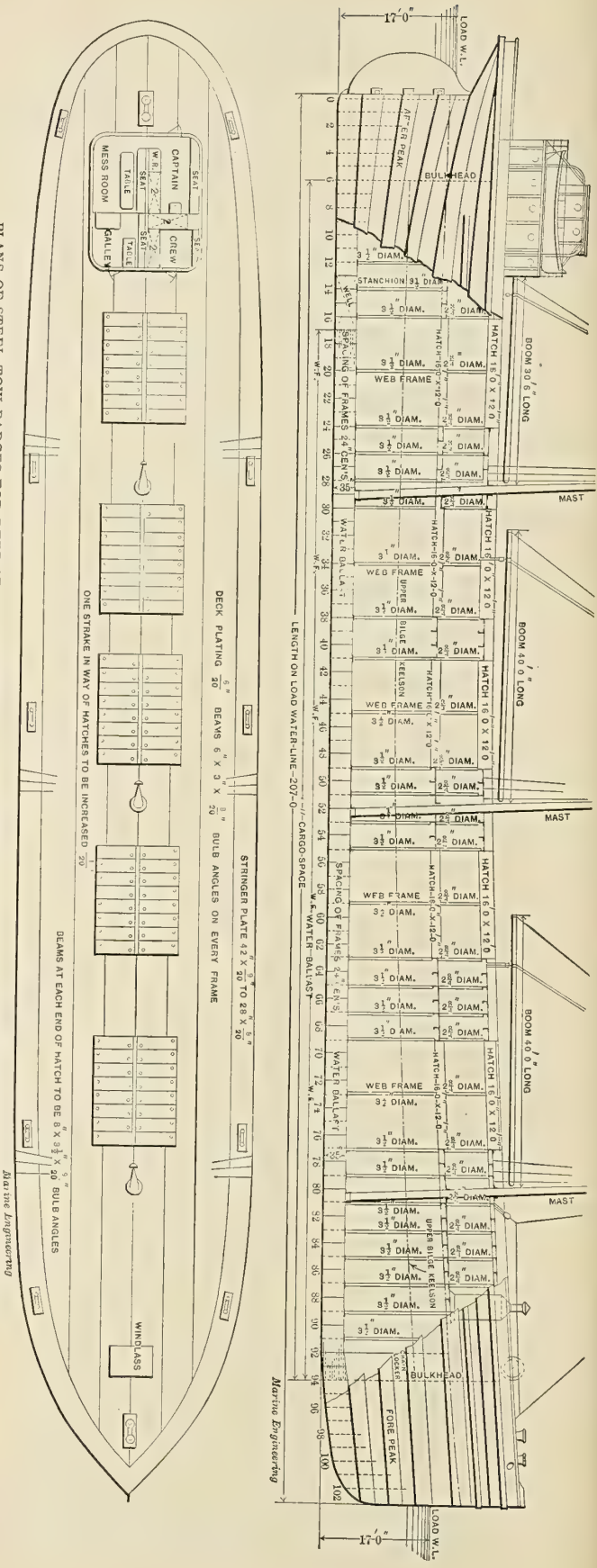
There are, however, examples of good steel construction to be met with in the Atlantic coast trade—vessels designed especially for this service. Of this type are the barges here described. These were built for the J. B. King Transportation Co., Staten Island, New York, by the Burlee Dry Dock Co., of Port Richmond, Staten Island. They are substantial, seagoing vessels, built for towing between the Bay of Fundy and the port of New York, and are designed to carry 2,067 tons on a draft of 17 ft. Their principal dimensions are:

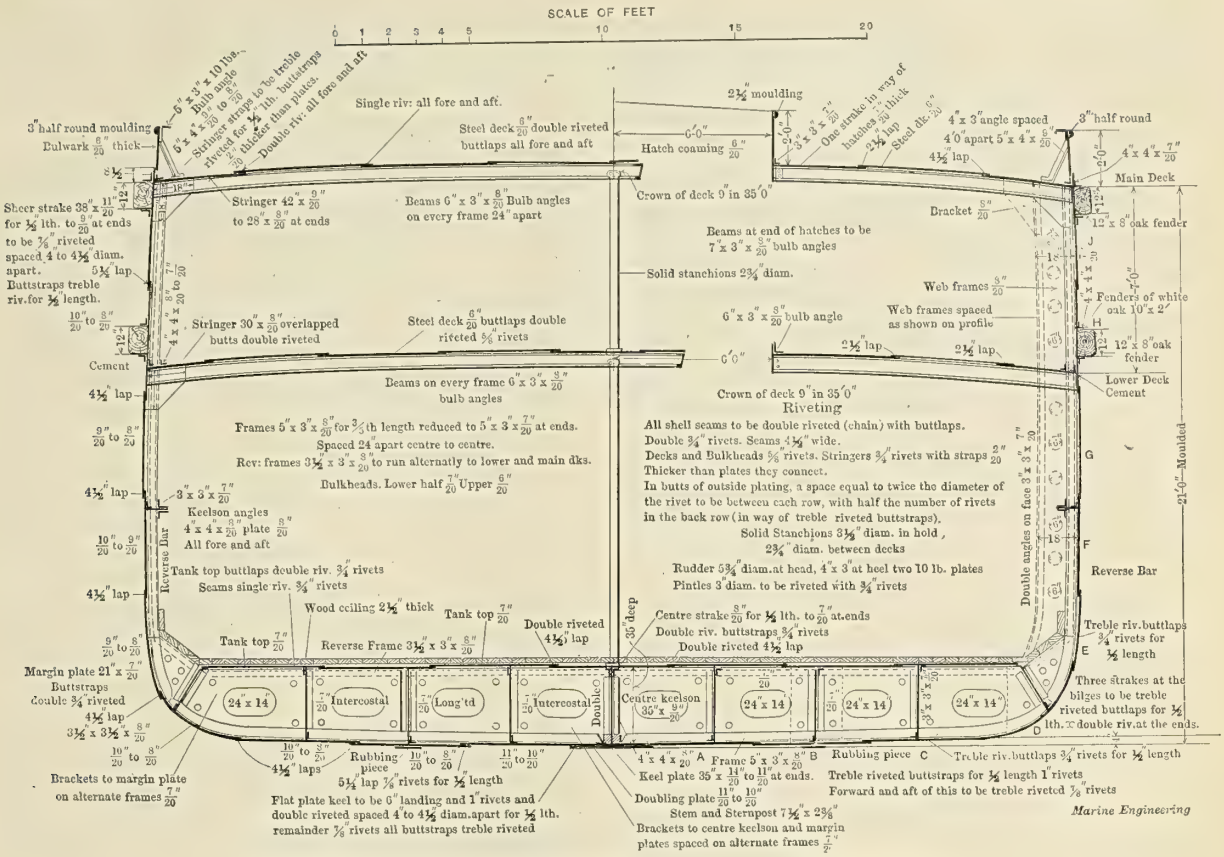
Length overall	215 ft. 0 in.
" bet. perps.	207 " 0 "
Breadth, moulded	35 " 0 "
Depth, moulded	21 " 0 "
Draft, loaded	17 " 0 "

As will be seen in the accompanying plans the barges have steel hulls, two steel decks and steel house aft, and a double bottom for water ballast. As they are identical the description of one will answer for all.

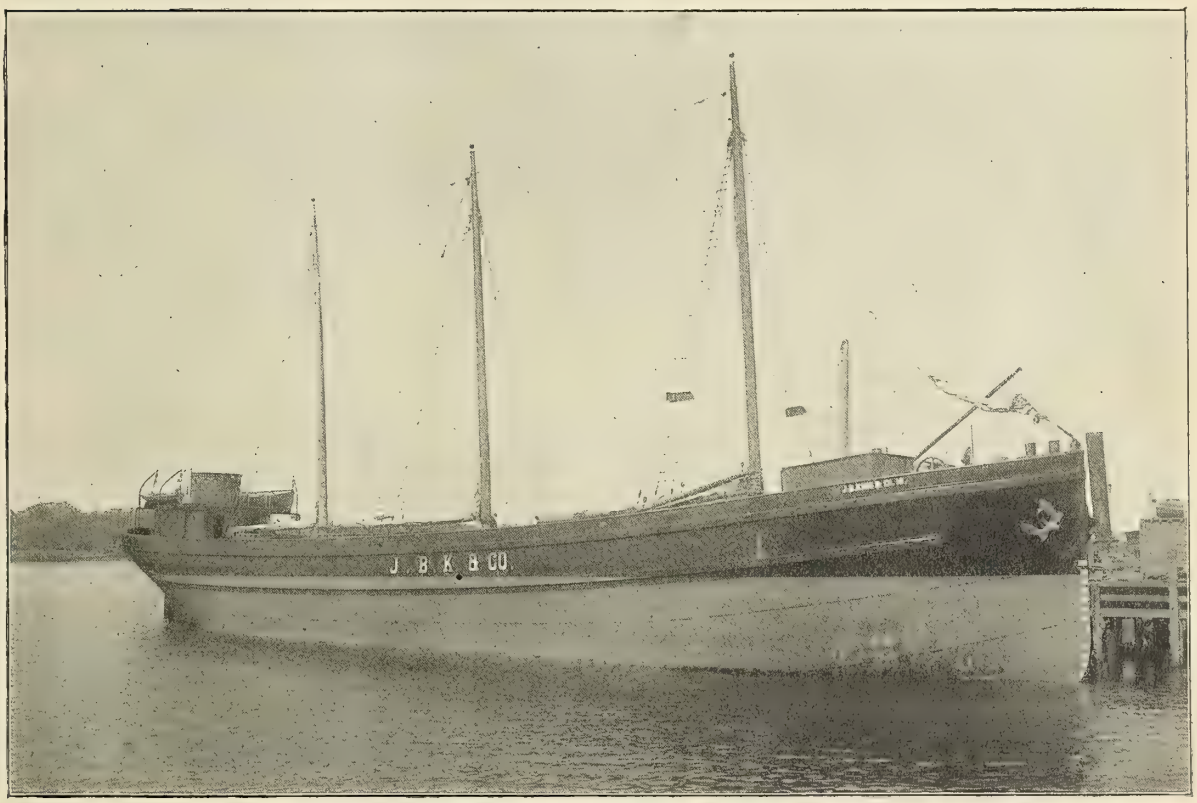
Mild steel of between 50,000 lb. and 60,000 lb. tensile strength was specified for the hull. The flat plate keel is 35 in. wide with doubling plate on the inside, the two well riveted together. The frames are angle bars 5 in. by 3 in. spaced 24 in. centers in one piece from the tank side to the main deck. Reverse frames are 3 1-2 in. by 3 angles following the tops of the floor plates and cut at the tank side, every alternate frame extending to the main deck and intermediate frames to 6 in. above the lower deck stringer plate. The floor plates are fitted in the double bottom on every alternate frame, 35 in. deep, and stiffened at the upper edges by the reverse frames, the intermediate frames being connected to the center keelson and tank margin plate with large bracket plates. All floor plates are lightened with manholes.

PLANS OF STEEL TOW BARGES FOR DEEP SEA TRADE—BUILT BY THE BURLEE DRY DOCK CO., PORT RICHMOND, STATEN ISLAND, N. Y.




SCALE OF FEET
0 1 2 3 4 5 10 15 20
Riveting
All shell seams to be double riveted (chain) with buttlaps.
Double ¾" rivets. Seams 4½" wide.
Decks and Bulkheads ⅝" rivets. Stringers ¾" rivets with straps
Thicker than plates they connect.
In butts of outside plating, a space equal to twice the diameter of the rivet to be between each row, with half the number of rivets in the back row (in way of treble riveted buttstraps).
Solid Stanchions 3½" diam. in hold,
2¾" diam. between decks
Rudder 5⅜" diam. at head, 4" x 3" at heel two 10 lb. plates
Pintles 3" diam. to be riveted with ¾" rivets
Main Deck
Lower Deck
Cement
Reverse Bar
Intercostal
Long'tl
Intercostal
Double
Centre keelson
Keel plate
Stem and Sternpost
Frame
Rubbing piece
Flat plate keel to be 6" landing and 1" rivets and double riveted spaced 4" to 4½" diam. apart for ½ lth. remainder ⅞" rivets all buttstraps treble riveted
Brackets to centre keelson and margin plates spaced on alternate frames
Forward and aft of this to be treble riveted ⅞" rivets
Marine Engineering

MID SECTION OF 2,000 TON STEEL TOW BARGES FOR ATLANTIC COAST TRADE.



PHOTOGRAPH OF 2,000 TON STEEL SEA GOING TOW BARGE FOR J. B. KING CO.

The center keelson runs the whole length of the double bottom. It is 35 in. wide and is connected to the double bottom and keel plate by 4 in. by 4 in. double angles. On each side of the center keelson three plate girders run the whole length of the tank.

There are twelve belt frames, one in the middle of each hatch. Two watertight bulkheads are fitted, all pipes and connections through these bulkheads being made watertight.

Main deck beams, 6 in. by 3 in. bulb angles, are on every frame except at the watertight bulkheads and the ends of hatches. Lower deck beams of 6 in. by 3 in. bulb angle are secured to all frames fore and aft by gussets. The main deck is steel with all double laps double riveted. In the hold there is a fore and aft row of iron stanchions along the center line, spaced 4 ft. apart, riveted at heads and heels to the beams and tank top. The 'tween deck stanchions are similarly spaced and there are extra stanchions under the towing bitts, windlass, etc. There are five hatches with main deck coamings 2 ft. high and lower deck coamings 6 in. high.

Towing bitts are fitted at the forward and after ends, secured to the deck, and supported underneath by heavy iron stanchions. There are five pairs of cast iron double bitts on each side.

The deck house is 20 ft. long and about 16 ft. wide in the widest part. In the pilot house overhead there is accommodation for the skipper.

Spars and sails are fitted for a three masted fore and aft schooner. The standing rigging is of galvanized wire set up with turnbuckles.

On the 'tween deck forward of the forward bulkhead the machinery is installed. This includes a vertical donkey boiler 4 ft. dia. and 8 ft. high, fitted with injector and small feed pump. A bilge and tank pump of the duplex pattern 7 1-2 in. by 8 1-2 in. by 10 in. is fitted. This is piped so as to pump separately from each tank and well, and there is also a sea connection. The discharge is overboard or through three hose connections as desired.

On deck in a house forward a double drum hoister with double cylinders 7 in. dia. and 10 in. stroke, designed to raise 4,000 lb., single whip is installed.

A messenger chain connects the hoisting engine with the windlass forward, and this is also fitted to be operated by hand. The chain pipes lead to lockers in the lower hold.

Two Baldt steel anchors of 3,600 lb. and 2,200 lb. respectively are carried.

A hand steering gear with 6 ft. wheel is fitted in the pilot house and on deck there is a hand pump with 4 in. suction.

There are two water tanks fitted, each with a capacity of about 2,000 gal.

Two boats are carried, one 22 ft. and one 16 ft., in accordance with the U. S. regulations.

Since they were finished these barges have seen considerable service, towing at sea under favorable conditions, when loaded, at the rate of about 9 knots.

A consolidation of the formerly separate interests of the famous Union and Castle steamship lines has been effected, and all the vessels will now fly one flag. These lines maintain regular communication between English and South African ports.

A SIMPLE EXPLANATION OF THE CONSTRUCTION AND USES OF THE PLANIMETER.—II.

BY CECIL H. PEABODY.

The planimeter shown by Fig. 3 has an adjustable tracing-arm; it can be set to mark lettered 10□" with the arm 4 in. long, and will then be used just as Figs. 1 and 2 are used. The measuring-wheel is set beyond the hinge, and will consequently roll backward as the tracing-arm swings forward, but the effect of the swinging of that arm forward and backward to the original position at the starting point after tracing a diagram will finally have no effect on the area recorded by the instrument, provided that it is used as described. If the tracing-arm is long enough, it may be set to give 8 in. from the hinge to the tracing-point, in which case one revolution of the wheel will correspond to 8×2 1-2 $= 20$ sq. in.; the readings in turns and decimals of a turn of the wheel are now to be multiplied by 20 to get the area in square inches.

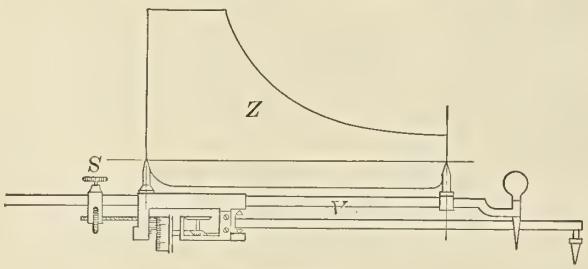


FIG. 11.

One square foot is equal to 144 sq. in., or $\frac{1}{10}$th of a square foot is 14.4 sq. in. In order to have one turn of the wheel record 14.4 sq. in., it is sufficient to make the tracing-arm

$$14.4 \div 2.5 = 5.76$$

inches long. A mark on the tracing-arm lettered $\frac{1}{10}$□' enables us to set the instrument at that length so that it may be used to measure areas in tenths of a square foot.

Again, one decimeter is equal to 3.979 in., and one square centimeter is equal to

$$\overline{3.979}^2 = 15.5$$

sq. in.; therefore, to have the planimeter record square decimeters it is sufficient to make the tracing-arm

$$15.5 \div 2.5 = 6.2$$

inches long. A mark lettered 1 □dec. allows us to set the arm for this purpose.

Finally, the arm is provided with two points on the back, by aid of which the length of the tracing-arm can be made equal to the length of the indicator diagram, as shown by Fig. 11. If the instrument is set in this manner and an indicator diagram is traced, the reading of the wheel will give the mean height of the diagram in 40ths of an inch, each subdivision of the wheel being read as $\frac{1}{40}$ of an inch. If the scale for the diagram is 40, then the reading of the planimeter gives the mean effective pressure directly. The mean effective pressure for other scales ordinarily used for indicator diagrams can be easily obtained; for example, with a 60 scale it is sufficient to multiply by 1.5 or to

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add one-half to the reading of the planimeter. To understand this use of the instrument, it must be remembered that the mean height of an indicator diagram, that is, the height of a rectangle having the same area, is obtained by dividing the area in square inches by the length of the diagram. Now, the area corresponding to one revolution of the wheel of a planimeter is equal to the circumference of the wheel multiplied by the length of the arm. Consequently when the arm is made equal to the length of the diagram, omitting to multiply by the length of the arm is equivalent to dividing the area by the length of the diagram; the reading of the wheel gives the resultant distance over which it has rolled. Since the circumference of the wheel is 2 1-2., in $\frac{1}{100}$ of the circumference is $\frac{2\cdot5}{100}=\frac{1}{40}$ of an inch.

Thus far it has been assumed that the pivot of the guiding-arm is outside the diagram to be measured. In dealing with large areas it may be convenient to place the pivot near the middle of the diagram, and to trace its perimeter with a continuous forward motion of the tracing-arm around to the starting-point. To find the area of the diagram add a constant given by the makers and engraved on the instrument to the difference of the initial and final readings.

The way in which the planimeter measures such a figure may be investigated by aid of a diagram like Fig. 12, which is drawn by first moving the tracing-arm parallel to itself, as from *hp* to *iq*, and then pivoting it about the hinge, as from *ig* to *ir*, and so on alternately entirely round to the starting-point. The area of the figure is made up of three parts: (1) The sum of the areas of the parallel-sided figures, like *hpqi*, which are properly measured and recorded by the planimeter; (2) the sum of the sectors, like *qir*, which

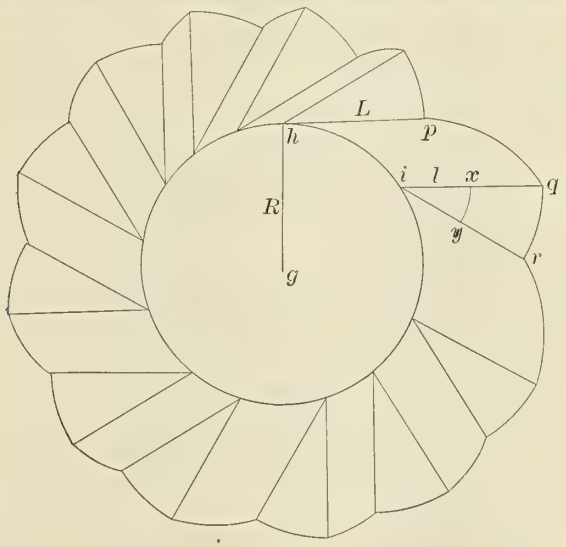


FIG. 12.

sum is equal to πL^2, the area of circle having the length of the tracing-arm for a radius, and (3) the area πR^2 of the circle described by the guiding-arm *gh*. While the tracing-arm is swinging from *ig* to *ir* the wheel rolls over the arc *xy;* the sum of the several arcs, like *xy*, is the circumference $2\pi l$ of a circle, having for its radius the distance of the wheel from the hinge; the planimeter adds to the proper record of the areas of the parallel-sided figures an amount, $2\pi lL$, which must be subtracted to get the true area of the figure. The figure consequently has for its area the record of the planimeter plus the constant.

$$\pi L^2 + \pi R^2 - 2\pi lL.$$

This constant depends on the lengths of the arms and the position of the wheel; a planimeter with an arm of fixed length, like Fig. 1, will have one value for this constant, which may be found engraved on the weight which holds down the pivot; the planimeter shown by Fig. 3 will have a constant for each setting of the arm engraved near the mark for setting the arm.

The wheel of the planimeter shown by Fig. 3 being beyond the hinge will roll *backward* while the arm is

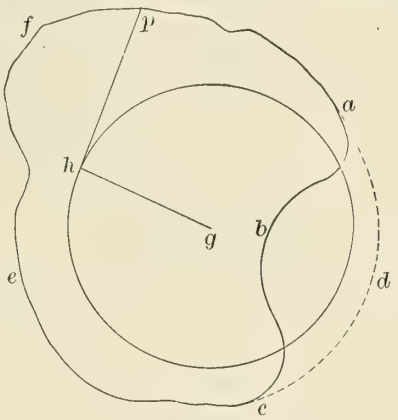


FIG. 13.

swung through an angle; consequently the term $2\pi lL$ will have the position sign in the above equation.

In Fig. 12 twelve sectors of 30° each were chosen so that it shall be more immediately evident that this sum is a circle having the tracing-arm for a radius. But it is evident that the sum of such sectors, whatever their angle, must be a circle, since the arm makes one complete revolution in passing round from *hp* to *hp* again, while the outline of the figure is traced. An approximation to any figure having a form like Fig. 12 can be obtained by taking a sufficient number of figures like *hpqi* and sectors like *qir;* or if the true outline is traced the planimeter will give the basis for determining the area, allowing for the constant. Moreover, the planimeter can be used to measure a diagram like Fig. 13, which lies partly outside and partly inside the circle described by the guiding-arm *gh*. For it is clear that we can apply this method for measuring the figure *adcef*, and that we may (after returning the tracing-point to *a*) subtract the area *abcd* by tracing it in that order, *i. e.*, toward the left; but since the dotted line *adc* will in that case be traced twice, once forward and once backward, we will get the same result by omitting it, that is, by tracing the outline *abcef* in the first instance.

According to a recent cable dispatch from Constantinople, the Turkish torpedo boat *Schamyl* blew up in the harbor of Beyrout, Syria, and 21 of the crew were killed. No boat of this name appears in the list of Turkish naval vessels. There is, however, the *Seham*, 127 ft. long with a speed of 22 knots. This boat was built about eight years ago.

AN ACCOUNT OF A RECORD-BREAKING TRIP ACROSS THE PACIFIC OCEAN.

BY WM. H. CRAWFORD, JR.

To many the suggestion of a record breaking trip across the Pacific would be a novelty, for it is to the Atlantic trade, chiefly, that persons interested in marine affairs are accustomed to look for record smash-

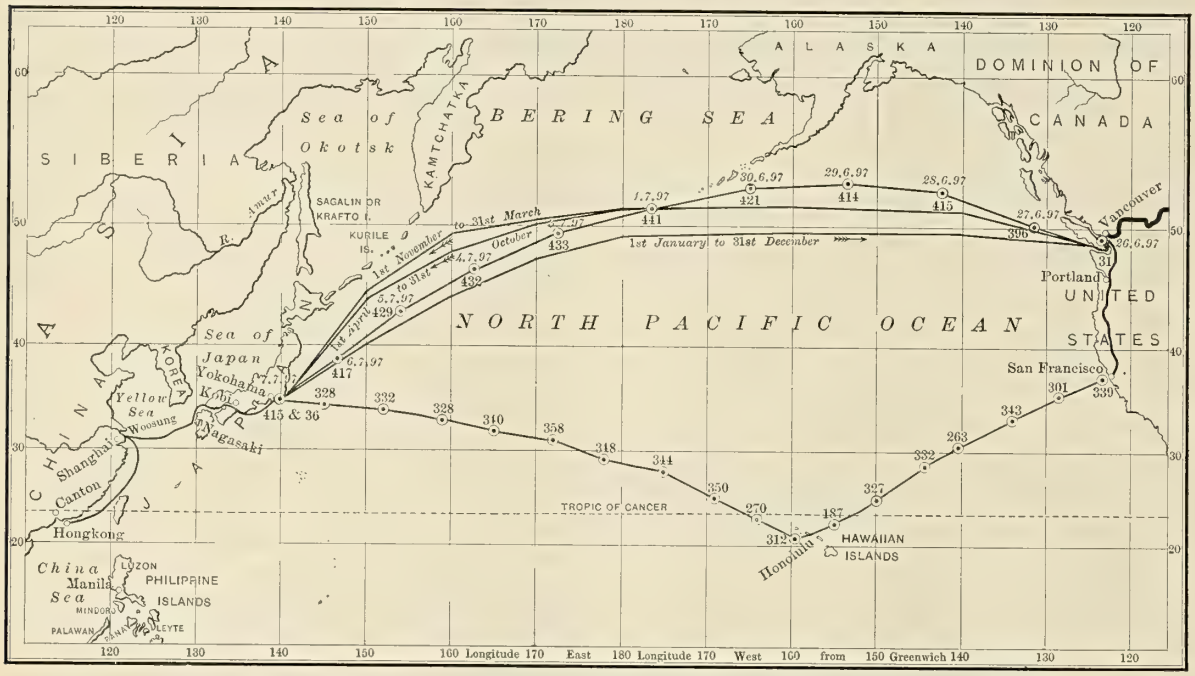


CHART OF NORTH PACIFIC OCEAN SHOWING STEAMSHIP ROUTES AND COMPARATIVE DAILY RUNS.

ing passages. Competition on the Atlantic has called forth the utmost skill of the shipbuilder and strained the resources of the ship-owner; whereas, on the Pacific things have moved along in such a quiet way that comparatively few persons on learning the duration of a trip across that ocean would know whether it meant fast or slow speed.

Recent happenings of national importance, however, have created a lively interest in matters relating to the Pacific ocean, and therefore it seems timely to recall a successful attempt to lower the Transpacific record. This, indeed, was before the days of active competition, and it was a race against time and valued reputation rather than against the necessity of lowering the record of a rival company.

As is generally known there are two important routes from the Pacific coast of North America to the Orient; one from San Francisco via the Sandwich Islands to Yokohama, and thence south to Hong Kong, and the other from Vancouver or Puget Sound, following the great circle track north, skirting the Aleutian Islands, the coast of Japan to Yokohama, and then south, as the former route. The distance from San Francisco to Yokohama via Honolulu is 5,428 miles, and it takes from 16 to 18 days to run over, while the northern route is 4,270 miles long, and steamers usually cross in from 13 to 14 days.

The Canadian Pacific S. S. Co. operates three first class steamships regularly between Hong Kong and Vancouver. These vessels* are named the *Empress of Japan,* the *Empress of India,* and the *Empress of China.* They are very handsome vessels, with clipper bows, two smoke stacks and three pole masts. They were built at Barrow, on the East coast of England, in 1891. and are of these dimensions: Length, 485 ft.; beam, 51 ft.; depth, 36 ft.; displacement, 8,500 tons, and 10,000 I. H. P. The company receives a large sum from the British Government for the carriage of mails, and there is a penalty of $2,500 for every 24 hours over the contract time, when the mails are late.

The regularity with which these steamers cover the 4,000 odd miles across, both winter and summer, is such that the service has come to be known as the "Ferry Line." It was my good fortune in June, 1897, to be a passenger from Montreal to Vancouver over the C. P. Ry. and on the S. S. *Empress of Japan* from Vancouver to Yokohama In crossing the Selkirk Mountains on the C. P. Ry., we met with great delay by reason of unprecedented floods, which carried away an important bridge, so that on reaching the western terminus of the line we were no less than 6 days and 19 hours late. This train was the regular steamer connection with the through mails, due to arrive 24 hours before sailing time, so the *Empress of Japan* was forced to await its coming.

No time was lost in transferring passengers, mails and baggage from train to steamer, and within two hours after our arrival at Vancouver we were steaming down Puget Sound on what turned out to be the fastest run ever made across the Pacific Ocean. Special preparations had been made for it. The coal supply was nearly doubled, so much being crowded on board that piles of it remained in sight on deck for several

* For a photograph of these ships see March issue, page 98.—ED. MARINE ENGINEERING.

days. Reference to the accompanying chart will give a good idea of the daily runs, as compared with an average voyage via the Sandwich Islands.

Good weather favored us from the very start. The only drawback was a dense fog; but a ship has the ocean pretty much to itself up in this part of the world, so very little fear is occasioned by thick weather. It is a fact that up to about a year or so ago there were less than thirty steamers engaged in the regular service between the Pacific Coast and the Orient.

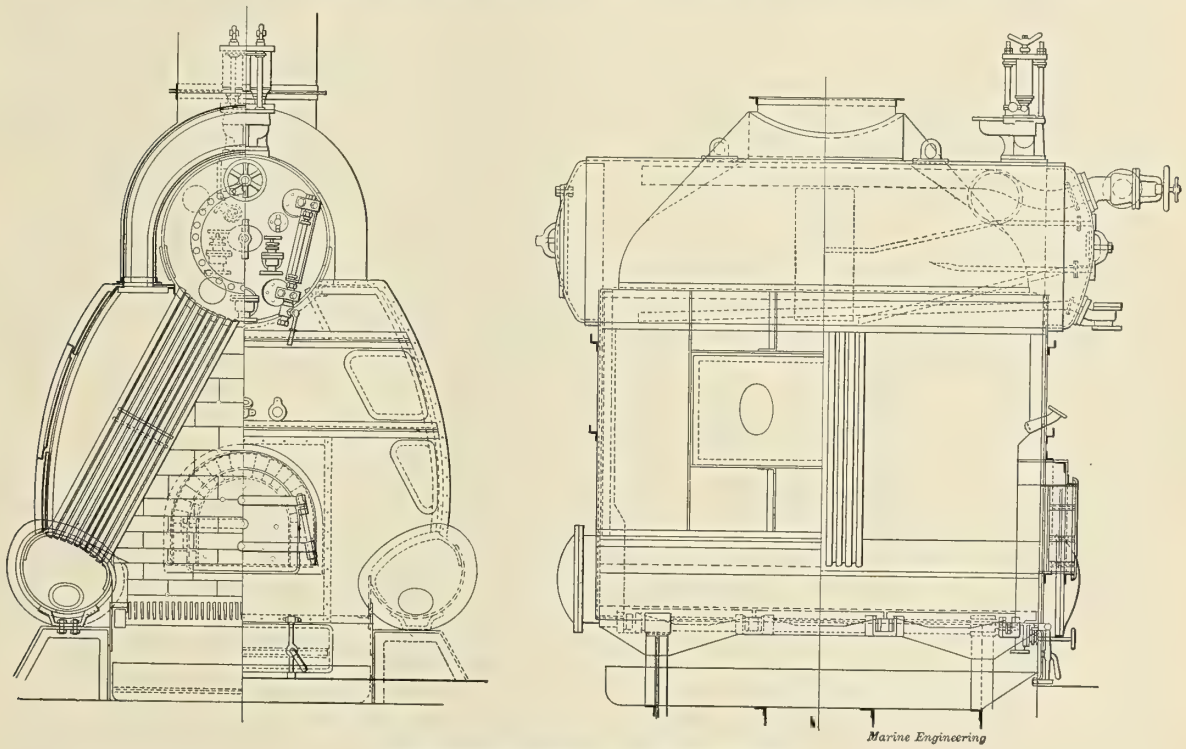
On this particular voyage not a stick was sighted from start to finish, and the engines kept up their continual grind day after day without even a slow down, until July 7, when the coast of Japan was sighted. The same day, by 1 o'clock in the afternoon, we crossed the line at Kannonsaki Light, and steamed into Yokohama harbor with a record of 10 days and 3 hours to our credit, and the remarkable average speed for the 10 days of 17.14 knots. No excessive vibration was noticed during the entire trip, and the performance was all the more creditable when it is considered that the engines were ready to start right off again and run for 7 days more, to reach Hong Kong. The time spent in Yokohama was just enough to allow for taking on a fresh supply of coal before the *Empress* started again. Stops were made at Nagasaki and Shanghai, and finally, after 17 1-2 days of almost continual steaming, the anchor was dropped in Hong Kong harbor with still a margin of an hour or so to save the late mail fine, and with a record of speed across the Pacific Ocean that far surpassed anything hitherto accomplished, and which stands unbeaten to-day.

A decision to purchase the Holland submarine torpedo boat has been reached by the U. S. Government.

COMMERCIAL TYPES OF WATER TUBE BOILERS BUILT IN AMERICA.—V.

Yarrow Water Tube Boiler.

The Yarrow water tube boiler is the invention of A. F. Yarrow, the English torpedo boat builder, who has installed it in the large number of torpedo boats and destroyers he has turned out for various navies. It is of the small straight tube type, with a large central steam and water drum at the top and water chambers below, at the level of and extending along each side of the grate. The top drum and the bottom chambers are connected by a row of straight tubes at each side, the tubes being inclined inwards at an angle depending on the width of the grate. In the earlier boilers of this type the top drum was made in halves connected by a bolted joint. This was abandoned, however, in favor of the drum riveted up with butt joints and double butt straps. The lower tube plates were formerly made flat, but are now slightly curved and are lap riveted to the lower pockets. In both the drum and the lower tube plates the metal is of increased thickness where the tubes are expanded in. By reference to the accompanying engravings it will be noticed that there is a large manhole in the back end of the upper drum, with cover bolted on. This permits of free ingress to the interior of the drum, and without the necessity for breaking the joints of any connections. In the center of the manhole plate there is a small hand hole and a similar hole is located in the front end of the drum for purposes of ordinary inspection. The ends of the water chambers, front and back, are flanged and closed by curved heads bolted in place. Small sludge doors are fitted in these bottom heads. By



DRAWINGS OF YARROW WATER TUBE BOILER.

opening up the top drum and the bottom chambers, the inside of every tube in the boiler can be inspected throughout its entire length, by the aid of a portable lamp, and any necessary cleaning can be readily accomplished. In the earlier boilers copper tubes were used, but they are now invariably of solid drawn steel, galvanized inside and out. The tubes are set in straight rows front to back, each alternate row being staggered, so that the gases are broken up and made to pass around the entire surface of the tubes on their way to the stack. By a suitable arrangement of baffles the path of the gases is controlled. This boiler is not fitted with any independent downcomers, the circulation being maintained in the generating tubes, the upper ends of which are, of course, submerged. In no part of the boiler is the metal exposed to the direct action of the gases on the one side and steam only on the other. In the casing which completely encloses the boiler, and which is lined with fireproof material, doors are placed in the ends and sides so that the exteriors of the tubes farthest from the grate can be got at readily. In small boilers of this type only one fire door is needed, but in those of large size, with wide grates, two or three doors are provided for working the fires. This boiler is built to withstand the most severe use. Not only has it been fitted in torpedo craft, but in large war vessels, steam yachts, and other craft. It is built in England by Yarrow & Co., Poplar, London, and the exclusive rights in this boiler for the United States are held by The Willam Cramp & Sons Ship and Engine Building Co., Beach and Ball streets, Philadelphia, Pa.

FOREIGN NAVAL DEVELOPMENT AND THE EFFECT THEREON OF THE RECENT WAR WITH SPAIN—II.*

BY LIEUTENANT COMMANDER GEORGE H. PETERS, U. S. N.

ARMOR.

In no respect has there been a more marked crystallization of naval opinion abroad, of late, than that which has taken place on the question of the best distribution of the weight assigned to armor in a ship's design. All officers are now in accord that protection must be widely diffused, and that it cannot be restricted to the water-line and gun positions. The trend of professional opinion in the British navy has been in this direction for some time past, as is evidenced by the latest battleships and armored cruisers. Elsewhere there have been designs of date not much prior to the war with Spain which showed a very wide expanse of side without protection, while heavy armor guarded a few parts. A few years ago France produced, in the *Dupuy de Lôme*, an armored cruiser lacking in size, but having admirable general protection, but there has not been adherence to this feature. Some of the later foreign armored cruisers have no protection between the water-line belt and the gun positions on the main deck, but current discussion shows that in battleships and armored cruisers laid down hereafter this will not be repeated. The appalling disablement of crew, which, under well-directed gun fire, may occur on board armored ships lacking widely distributed protection is now fully appreciated. The need of extending the armored water-line belt to the extremities is also urged, and the protection of the personnel in the conning tower is regarded as essential.

The recent war confirmed and impressed the lesson of that between China and Japan as to the absolute necessity of protection of the personnel. Proving ground tests have shown for the latest new process face-hardened armor such a remarkable resistance to penetration that there can be much reduction of thickness, thus enabling the need for covering a more extended area to be met, although at increased cost. There has been a prompt acceptance of the new conditions.

In foreign armor contracts quality is made the feature of paramount importance, cost being a secondary consideration. The best type of armor procurable at the time is purchased. So general is this that it holds good, not only in the more important foreign navies, but even in some whose expenditures are necessarily much restricted. The fact is fully realized that if a ship whose armor is contracted for to-day is hereafter to be tested in battle against an opponent having protection of a superior quality, permitting better distribution, this one point may have a decisive influence on the result.

SPECIAL FEATURES OF CONSTRUCTION AND EQUIPMENT.

The destructon of the Spanish ships by fire caused by American shells has led to universal effort to abolish wood and combustible materials from naval vessels. This effort is marked by such vigor that its results may practically be regarded as accomplished. In some of the latest ships the furniture is of metal or of fireproofed wood, the steel bulkheads have ornamental asbestos covering, and the steel decks are given a plastic non-flammable coating. Decks partly of wood are being replaced by steel. In clearing ship for action nothing combustible is permitted above the protective deck. Canvas boats permitting disassemblage and stowage below will be tested for some purposes.

The action of the French budget committee, in declining to make provision for the repair and maintenance of certain old wooden ships, recognizes the lack of military value of such vessels. A step in the same direction is the replacing of old wooden French ships for colonial service by others of more modern type. In these measures France is but following the policy already adopted in other navies.

Provision for extinguishing fire has been much extended and greatly increased. Fire mains are now carried under the protective deck, with numerous vertical leads from them.

The general adoption of water-tube boilers by progressive foreign navies has passed beyond the stage of discussion and may be regarded as an accomplished fact. The only point now remaining open in this respect is the question of the best type.

Search-lights, rapid-fire guns of the secondary batteries, flotillas of picket boats when at anchor, and numerous flanking torpedo boat destroyers and cruisers when under way, form the chief defense of battleships against torpedoes. Recent improvements and attachments give torpedoes much greater range and accuracy than they have had heretofore and increase the need of defense against them. Thus the best position for search-lights is one of great importance and has been much

*From Notes on Naval Progress issued by U. S. Office of Naval Intelligence, Washington, D. C.

investigated abroad. The present practice is to mount some search-lights aloft and others as low as they can be used in a sea way. The low ones, having their beams parallel to the water, are best for picking up an object on the surface, but their beams blind the gun pointers of the secondary battery. The lights, which are placed high, serve to illuminate the object after it is picked up. It is evident that co-operation between the search-lights and the battery is necessary.

Though some foreign battleships still have torpedo nets, they are no longer regarded with favor abroad.

Military masts are considered important for battleships. The tendency is to shorten them, and their development is in the direction of armored towers with circular stairways, enabling men to go aloft to the fighting tops and to have ammunition supplied to them therein under protection. There is communication from the tops to the conning towers to facilitate reporting ranges and signals. For cruisers the present tendency seems to be to use pole masts.

The arguments against an extensive use of longitudinal bulkheads below the protective deck, which followed the capsizing of the *Victoria* after her collision with the *Camperdown*, have been counteracted this year by the fact that the German armored coast defense ship *Aegir* was saved from sinking as a result of collision during fleet maneuvers by flooding compartments on the side opposite the injury, thus heeling the ship sufficiently to bring the leak above the water line. It is now held that valves to permit the passage of water across to opposite compartments will obviate the danger of capsizing.

Cellulose protection is still used. In some cases cork is preferred, in spite of its greater weight. Some authorities hold that to avoid any danger of corrosive action it is well to keep the coffer-dams empty, clean and dry, ready to be packed with cellulose in case of war.

Atlantic Liners.—Several of the large transatlantic steamships which have been engaged in transporting troops to South Africa have been released by the British Government. The Anchor liner *City of Rome* has resumed her New York sailings from Glasgow. The White Star liner *Majestic* will also be back in her old trade shortly, and the Cunarder *Umbria* is soon to follow.

In a special report of the Association of Engineering Societies by Secretary John C. Trautwine, Jr., attention is called to the very prosperous conditions of this organization. Its individual membership is now 1,475, made up of professional men who are members of various local scientific societies in the East, South, Middle West and Pacific slope. There has been an accompanying steady increase in the assets, so much so indeed that a rebate on assessments was granted for the purpose of reducing the surplus—this amounted to $2,443 at the end of 1899. In the proceedings of the Association, publication of many important technical and scientific papers is made at a comparatively small cost to each organization, the expenses of the journal being distributed over the entire membership. In this way many of the smaller societies are enabled to have a permanent record of their transactions, which, on account of the cost, they could not accomplish unaided.

LAUNCHES—HOME AND FOREIGN.

S. S. Kvichak.—At the yard of Wolf & Zwicker, Portland, Ore., the new steel vessel *Kvichak*, for the Alaska Packers' Association, was launched April 14. Her tonnage is 1,063 tons gross.

Tug Tormentor.—An ocean-going tug, the *Tormentor*, was launched at the yard of the Atlantic Works in East Boston, Mass., March 31. The boat is to the order of the Red Star Towing & Wrecking Co.

Sch. Calumet.—A four masted wooden schooner, the *Calumet*, was launched by Kelly, Spear & Co., Bath, Me., on April 14. The vessel is: Length, 180 ft.; beam, 40 ft.; depth, 18 ft. John S. Emery & Co., Boston, Mass., are the owners.

Tug Zetus.—At the McKie shipyard, East Boston, Mass., the harbor tug, *Zetus*, was launched March 31. She was built for the local service of the Boston Tow Boat Co., and was christened by Miss Alice Flynn, daughter of the superintendent of the company.

Barge Black Diamond.—The three masted wooden tow barge *Black Diamond*, for the Bee Line Transportation Co., was launched at the New England Co.'s yard, Bath, Me., April 9. The barge is of these dimensions: Length, 188 ft.; beam, 34 ft.; depth, 18 ft.; carrying capacity, 1,800 tons.

Sch. Malcolm Baxter, Jr.—The 4-masted, 1,700 ton schooner, *Malcolm Baxter, Jr.*, was launched at the yard of H. M. Bean, Camden, Me., March 29. Her dimensions are: Length, 216 ft. on keel, 226.2 ft. over all; beam, 45 ft.; depth, 20.8 ft. Her lower masts are 110 ft. long and topmasts 53 ft. long. White oak and southern pine were the materials used in her construction.

T. S. S. Lake Champlain.—A new steamer of about 8,000 tons dead-weight capacity for the Canadian-British trade of Elder Dempster & Co. was launched recently on the Mersey. The dimensions of this vessel are: Length, 465 ft.; beam, 53 ft.; depth, 38 ft. 7 in. to shelter deck; gross tonnage 7,500 tons. She is built to rate 100 A1 at Lloyds. Accommodation will be provided for about 100 saloon, 80 second cabin and 500 steerage passengers.

F. B. General Sumner.—A new ferryboat for the city of Boston, the *General Sumner*, was launched from the McKee yard, East Boston, April 7. She is built of wood and is fitted with compound screw engines. Her dimensions are: Length, 164 ft. 3 in.; beam, 57 ft.; depth of hold, 14 ft. The cabins are to be finished in white pine and burlap, with papier mâchè carvings. The seats will be of mahogany, and the floors will be laid in quartered oak.

S. S. Hyades.—At the Maryland Steel Co.'s shipyard at Sparrow's Point, Md., the S. S. *Hyades*, for the Boston Tow Boat Co., was launched March 27. This vessel is a sister ship to the S. S. *Pleiades* recently completed at the yard and put into service. The vessels are of the money earning tramp type, built especially for carrying coal or bulk cargo. The dimensions of the vessel are: Length over all, 350 ft.; beam, moulded, 47 ft.; depth at side moulded, 28 ft.; gross tonnage about 4,000 tons.

S. S. Excelsior.—For the first time in a number of years the inhabitants of New Haven witnessed the launch of a new vessel, March 31. On that day the wooden steamer *Excelsior* for the Brooklyn Grain Elevator Co. was put into the water at the yard of J. E. Marr in West Haven. The dimensions of the vessel are: Length, 154 ft. 8 in.; beam, 33 ft. 10 in.; depth of hold, 16 ft. Her machinery is to be installed at New York where the hull was towed.

S. S. Manna-Hata.—At Harlan & Hollingsworth's yard, Wilmington, Del., the S. S. *Manna-Hata,* was launched March 31. She is a sister ship to the *Chesapeake* launched earlier in the month, and reported in our last issue. In dimensions the new vessel measures: Length over all, 219 ft., between perpendiculars, 205 ft.; beam, 32 ft.; depth to upper deck at center, 23 ft. 3 in. She is built of steel throughout. She will be put on the Shriver Line running "outside" from New York to Baltimore.

S. S. William Cassel Rhodes.—At the Lorain yard of the American Shipbuilding Co. the steamer *W. C. Rhodes* was launched April 7. She was built to the order of the Lower Lakes Steamship Co., for trade through the Welland Canal and the St. Lawrence River canals, and is of these dimensions: Length, 252 ft.; beam, 42 ft.; depth, 26 ft. 6 in. The ceremony of christening the new vessel was performed by Miss Stella Hatch. The vessel will be used chiefly for carrying package freight.

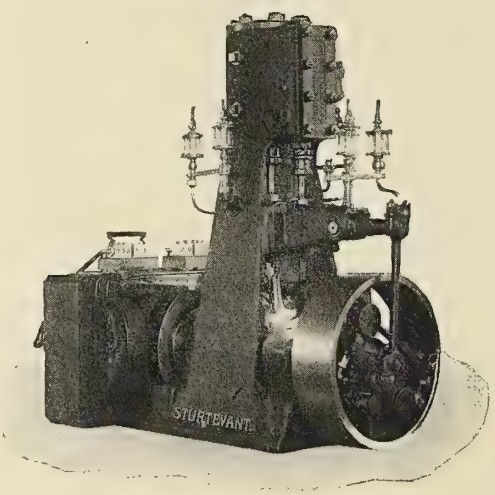
S. Y. Elfrida.—At the yard of the Gas Engine & Power Co., and Charles L. Seabury & Co., Con., Morris Heights, N. Y., the steam yacht *Elfrida* for Dr. Seward Webb was launched April 10. The yacht which is intended for use on Lake Champlain is built to pass through the canals to reach her destination. The overhanging ends will be carried on deck until the lake is reached, when they will be shipped. The dimensions of the new yacht are: Length over all, 141 ft., water line, 113 ft.; beam, 18 ft.; draft, 7 ft. 6 in. She will have twin screws driven by triple expansion engines. Two pole masts will be fitted. She will have a maximum speed of 16 miles an hour.

T. S. S. Morro Castle.—One of the largest and finest freight and passenger vessels ever built in this country was put into the water at Cramp's yard in Philadelphia, April 14. The new vessel, the *Morro Castle,* was originally laid down for the Plant Line, but later was sold to the Cuba Mail Steamship Co., more familiarly known as the Ward Line. In dimensions this fine ship measures: Length, 400 ft.; beam, 50 ft.; depth, 36 ft. 6 in.; displacement, 6,900 tons. She will be fitted with triple expansion engines of 8,000 I. H. P., driving twin screws, and is expected to attain a speed of 18 knots on trial. Her boilers are of the single ended Scotch type built for a working pressure of 170 lbs. Elaborate accommodation for about 250 passengers of all classes will be provided. The launching of the vessel was made the occasion of demonstrations of good will on the part of the employees toward the executive officers of the company, presentations of floral gifts being made by deputations representing workmen in the yard to both Charles H. Cramp and Edwin S. Cramp. The christening ceremony was performed by Miss Florence Cramp.

IMPROVED APPARATUS.

Small Lighting Set.

We illustrate in the accompanying engraving a very small generating set, designed primarily for lighting purposes, and built by the B. F. Sturtevant Co., of Boston, Mass. The engine has a cylinder 3 in. dia., and a stroke of 2 1-2 in. It is self-contained, as is clearly indicated, and the speed is regulated by a shaft governor. The valve is of the piston type; all bearings are adjustable, and are provided with direct oiling devices. A speed of 800 rev. per min. is attainable, and may be constantly maintained with accurate regulation. The generator is of the 2 1-2 K. W. size, designed to develop its rated output without sparking, and with a minimum temperature rise. The entire weight of the set is a little over 600 lb., the engine constituting a little over 40 per cent of this weight. The field frame is attached directly to the engine frame, and placed at the floor level so as to be as stable as possible. This arrangement was facilitated by the adoption of the consequent pole type, giving a four-pole field with only two field coils. As



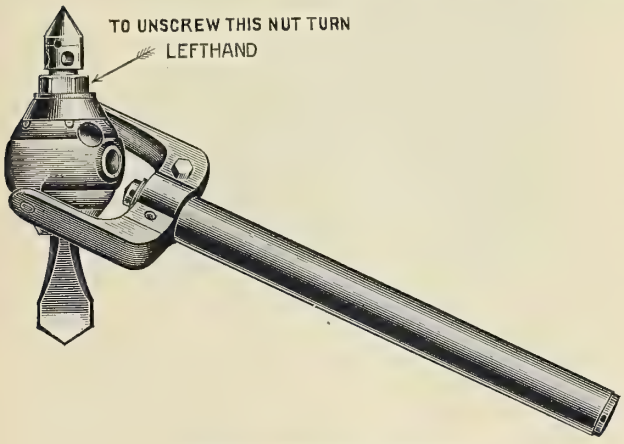
STURTEVANT LIGHTING SET.

these coils are placed on the horizontal pole pieces, the height of the shaft center is reduced to a minimum. The total floor area occupied by this set is only 21 in. by 35 in., and the total height is 30 in. This type of lighting set is built in sizes for 25, 37 and and 50-16 C. P. lights.

Williams Universal Ratchet.

An improved form of ratchet drill is shown in the engraving of the Williams universal ratchet. This tool differs in operation from the ordinary ratchet in that, instead of a to and fro motion, the handle can be worked in any direction. There are no bevel gears and no ball joints, and all bearings are cylindrical. The pawls do not slide lengthwise on the ratchet teeth. The universal quality of the tool is due to the fact that the axes of the two trunnions on which the handle turns form an acute angle with the axis of the drill. About two inches of motion at the end of the handle in any direction will drive the drill, and by the use of a collet holes up to 2 in. dia. can be worked. Inside the case there is a ratchet 1 3-4 in. dia., with 12 teeth and five

pawls, one of which is always engaged. Thus the pawls catch sixty times in a revolution, and much faster work can be accomplished than with the old style drill. The tool is made of forged steel and the springs

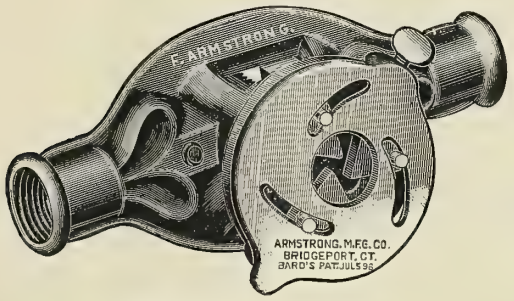


WILLIAMS UNIVERSAL RATCHET.

which actuate the pawls are made of finely tempered piano wire. The tool complete weighs 11 lb. It is in extensive use by steamship companies, railroads and machine and boiler shops. It is made by the Waterbury Tool Co., Waterbury, Conn.

Bard Adjustable Bushing.

The accompanying illustration shows the Bard adjustable bushing, a new appliance for use with die-stocks of all sizes. The bushing is fitted with three hardened jaws, which are moved to and from the center by means of a cam plate, and by fastening the plate with a thumb screw the jaws are firmly held in any desired position. The bushing is made to fit any die-stock in place of the common ring bushing, and adjusts to all sizes of pipes or bolts. The adjustable jaws always make a perfect center for the pipe and, fitting closely around the pipe, insure cutting a straight thread. When once attached to the die-stock it may

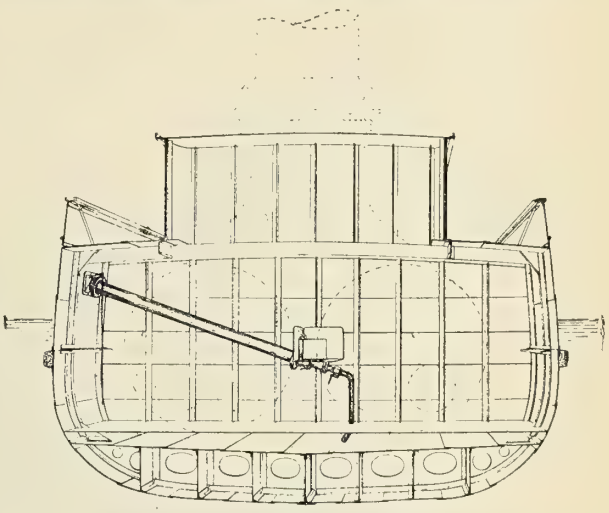


BARD ADJUSTABLE BUSHING.

always remain there, being adjustable to any size of pipe or bolts that the stock will thread. It thus does away with the necessity of carrying a number of loose ring bushings with each stock. In threading short nipples with this bushing, it is never necessary to file down the coupling of the nipple holder. Bushing No. 3 is made for use either with or without a leader screw, according to the stock in which they are to be used. For old die-stocks where a leader screw or follower is necessary No. 3 bushings are made (taking up to 2 in.) combined with a leading screw, all in one tool. This is a useful addition to an old style 2 in. die-stock, using solid dies. The Bard bushing is manufactured by the Armstrong Manufacturing Co., Bridgeport, Conn.

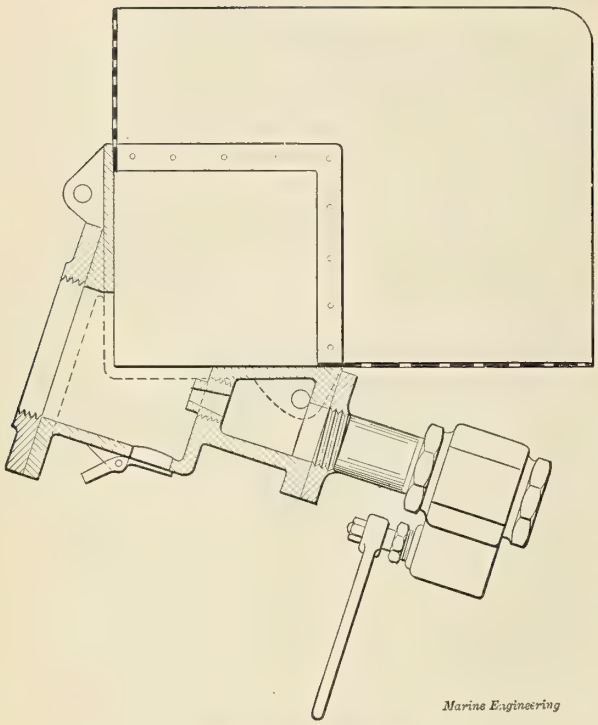
Detroit Ash Gun.

One of the most troublesome operations in connection with the engineer's department of a steamship is the getting rid of ashes. To lessen the labor attendant on this operation, and to enable it to be carried out expeditiously, the Detroit Shipbuilding Co. has designed an ash gun, by means of which the ashes are disposed of direct from the fire room floor without the necessity of any labor above decks. In the cross section of a vessel here printed, the gun is shown in position, with the discharge pipe leading up to the outlet on the ship's side above the water line. The form of gun illustrated in the detail drawing is extensively used on the Great Lakes and also in smooth-water vessels. What might be termed the



MID SECTION SHOWING ASH GUN IN POSITION.

"breech mechanism" of this gun consists of a cast-iron shelf or receiver (with an opening to the bore of the gun), placed at a convenient height from the floor in the boiler room, on to which the ashes are shoveled. Connection is made at the rear end of the gun with one of the ship's pumps supplying a jet of water under pressure. A throttle is placed under the shelf to control this jet, and when this is opened, and the gun loaded, the ashes are carried up the discharge pipe and shot overboard clear of the ship's side, without noise, dust or dirt. The discharge of the gun is 7 in. dia., and the inlet a little smaller, so that clinkers that can enter the opening are sure to be discharged. For vessels running on rough waters, the gun is fitted with an outboard valve at the muzzle to prevent the water entering the gun when the vessel rolls, and so getting down into the fire room. For sea-going vessels a gun fitted with a hopper instead of a shelf can be supplied. When not in use the hopper can be made watertight with a lid and rubber joint. This apparatus takes up very little space, and can be readily installed in any



MECHANISM OF ASH GUN.

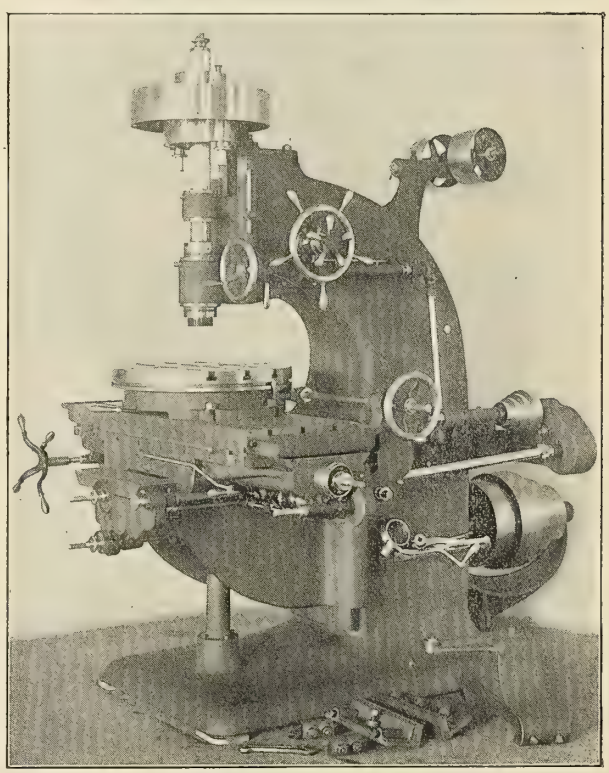
steamship. It is very rapid in operation, and the ashes are carried clear of the ship's side, thus avoiding damage to paint. The ash gun is manufactured by the Detroit Shipbuilding Co., Detroit, Mich.

Becker Milling Machine.

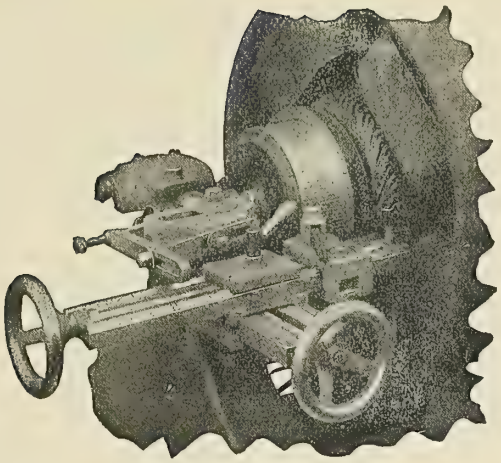
In the engraving of the Becker milling machine an improved form of machine tool is shown, which takes in a wide variety of work. It is very carefully built, and has well proportioned wearing parts. The spindle has large bronze bearings made adjustable for wear, the diameter at the main bearing being 3 in. Mills are secured rigidly by means of a draw bar, and large surface mills are fitted to the threaded nose of the spindle. The spindle driving pulley is mounted upon an adjustable auxiliary bearing, and is back-geared 5 to 1—the back gears are in duplicate to balance the action. The head has an automatic or hand movement of 9 in. and an automatic stop-dog which will throw off the feed at any point within the limit of its vertical movement, thus making this machine an excellent vertical boring machine. A micrometer stop gauge is fitted so that the depth of cut can be accurately adjusted. The platen is 51 1-2 in. long over all and 14 in. beam with 42 in. automatic feed in either direction, and is fitted with quick return motion geared 3 to 1. Of the same length as the platen is the saddle with automatic feed in and out of 16 in. The feed screws are fitted with accurately divided dials. The knee has an automatic vertical feed, and has a range which gives 21 1-2 in. in the clear between the spindle and platen and 16 in. between the spindle and the rotary table. This table is 22 in. dia., graduated on the periphery and fitted with adjustable dogs to trip the feed. Table feeds are derived from compounded gears, giving eight changes for each change of spindle speed, and by a further arrangement of gears sixteen changes of feed can be made for the rotary attachment. One advantage of this type of machine lies in the fact that the cutter and the work are always visible and easily accessible. By the use of special cutters much work can be done on this machine (recessing for example) which could only be accomplished on the lathe or planer, at far greater expense, and, of course, an infinite variety of work can be done with one setting. The machine is very solidly built, weighing about 5,000 lb. It occupies about 270 cu. ft. of space. Each machine is fitted with an automatic oil pump and all the usual attachments. It is manufactured by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

Commutator Truing Device.

A compact apparatus for truing up commutators of electrical generators is here illustrated. By the use of this apparatus the work can be done without dismembering the generator and removing the armature to a repair shop. In the engraving the apparatus is shown secured in position on a dynamo with the tool set for a cut. It is put in place by removing the cap of the bearing on the commutator side of the dynamo and clamping on the machine. This in construction is similar to a lath slide rest with both parallel and transverse motions. The tool post is of the ordinary type, with steel set screw for holding the tool fast. To prevent end play in the commutator when truing, the apparatus is fitted with an arm in which a threaded centerpoint is carried; this engages in the end of the armature shaft and holds it hard against the pulley end. For the best work a commutator speed of from 200 to



BECKER MILLING MACHINE.

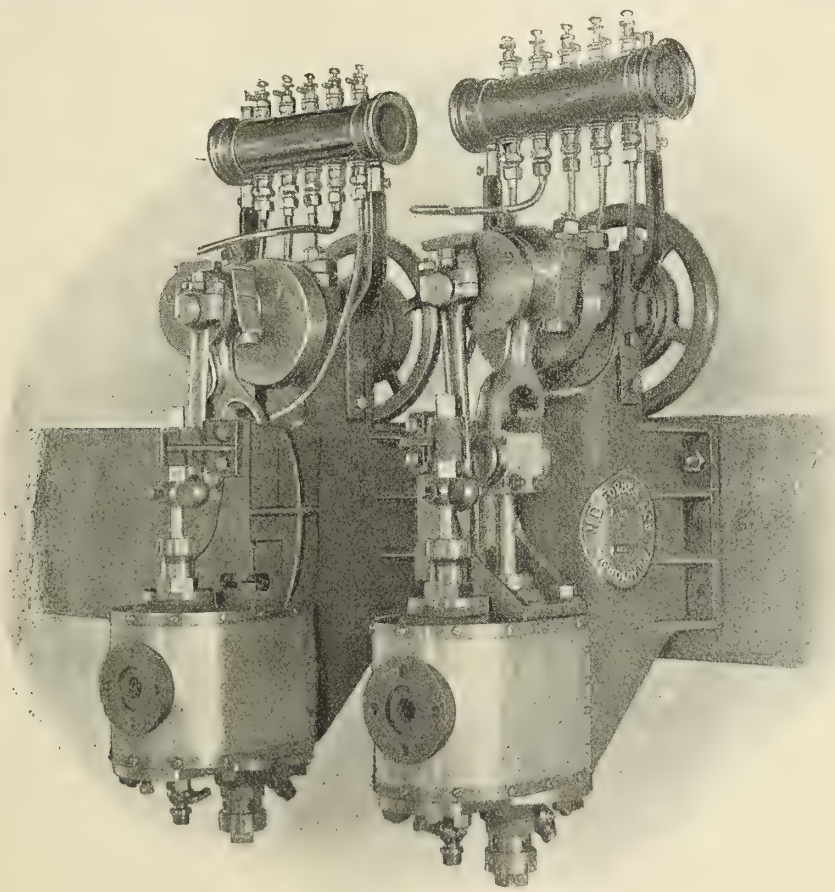


COMMUTATOR TRUING DEVICE.

250 ft. a minute is found desirable. The apparatus is manufactured by the Akron Electrical Mfg. Co., Akron, Ohio.

Circulating Pump Engines.

In designing and building the torpedo boats now on the stocks in the United States, it has been the desire of the Navy Department and the builders to as far as possible cling to well-accepted designs, modifying what has been well proven in the past to be of value to meet new conditions, thus practically eliminating in many cases the possibility of disaster. Private firms all over the United States have been aiding the Government in this respect by getting up special designs for auxiliaries, which the builders of torpedo boats have not taken in hand themselves. One of these designs is shown herewith. It represents a pair of small circulating pump engines built for the W. R. Trigg Co., of Richmond, Va., by W. D. Forbes & Co., of Hoboken, N. J. These engines are directly connected to the circulating pump shafts and although extremely stiff and strong are quite light, weighing only 135 lb. each. Their cylinder dia. is 4 in. and the stroke is 3 in., and they are capable of running up to quite high revolutions, say 600 or a little over, but, of course, as they are to be used with a circulating pump they will probably be run at very much less speed. These engines are fitted with relief valves on both ends of the cylinder, and these valves are large enough to relieve the cylinder very quickly, even if considerable water is trapped in the cylinder. A piston valve is used, which works in a liner in which the steam ports are milled. The crosshead pin is of tool steel hardened and ground, and regular navy material, as specified by the Bureau of Steam Engineering, is used throughout. The oiling device has been very carefully considered and the crank pin is oiled from the interior, the oil dripping into a circular groove in the back of a disk crank and being thrown out into the pin by centrifugal action.



FORBES CIRCULATING PUMP ENGINES

MARINE ENGINEERING

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Notice to Advertisers.

Copy for changes in advertisements must be in our hands not later than the 20th of the month to insure changes being made in the issue of the month following, and not later than the 15th of the month if corrected proof is to be submitted.

AN International Congress of Naval Architecture and Marine Engineering under Government auspices will be held at the Paris Exposition, commencing July 19 next and lasting three days. The Commission of Organization includes the leading representatives of the profession in France: M. de Bussy, inspector general of the reserve fleet, is president; MM. Bertin, Dagmard and Normand vice-presidents, and the other members are equally well known in engineering circles. The Commission has extended an invitation to all engineers, constructors of vessels, and motive and mechanical apparatus of all sorts employed in marine work, producers of materials employed in marine construction, and to yatchsmen, amateurs and others who are interested in the progress of marine construction and propulsion (locomotion maritime), to present to the Congress the result of their experiences, studies and researches. This they can do either by furnishing communications which will be read and discussed at the meetings, or by taking part personally in the discussions, or they will be welcomed as auditors pure and simple. Those who desire to participate in the Congress are requested to send their names and addresses, and profession or calling, without delay, to M. Borja de Mozota, administrateur du Bureau Veritas, Trésorier, Place de la Bourse, 8, Paris, France, together with a remittance of 15 francs, which is the price of membership. On the acceptance of this fee the member will receive a personal card of entry to the Congress and will also be entitled to receive the report of the proceedings. To extend its sphere of influence the Commission of Organization has appointed a committee of leading members of the profession throughout the world, and has at this time received a large number of acceptances which include: United States, Chief Constructor Philip Hichborn, U. S. N., Engineer-in-Chief George W. Melville, U. S. N., Clement A. Griscom, president, S. N. A. & M. E., and Charles H. Cramp; Britain, Lord Hopetoun, president, I. N. A., Chief Constructor Sir William White, R. N., Dr. Elgar, Lord Brassey and others; Germany, Carl Busley, Herr Blohm, of Blohm & Voss, Otto Schlick, and others; Italy, Sig. Soliani; Spain, Senor de Haro; Russia, Col. Gonlaieff; and other states by authorities. An effort has been made by the Commission of Organization to classify the different papers, and to this end it has arranged for the following separate sections: Section A, Naval Architecture; Section B, Construction of Hulls; Section C, Construction of Marine Machinery; Section D, Classification of Types of Vessels; Section E, Facilities for Loading Vessels in Port; Section F, Miscellaneous. Already a number of important papers have been arranged for, the list of titles and authors being as follows:

BERTIN Directeur du Génie Maritime, Paris, France.
STABILITY OF A PACKET AFTER COLLISION AT SEA AND SUBSEQUENT MEANS OF PRESERVATION.

BILES Professor Naval Architecture, University of Glasgow, Scotland.
STANDARDIZING THE RESULT OF SHIP CALCULATIONS.

BONNET Engineer, Havre, France.
USE OF THE METERINTEGRATOR IN CALCULATIONS FOR THE STABILITY OF SHIPS.

CHACE Civil Engineer, Newport News, Va., U. S. A.
SHIP BUILDING PLANT AT NEWPORT NEWS.

CLARK Engineer, London, England.
FLOATING DOCKS.

DEGREMONT-SAMADEN Engineer, France.
PRACTICAL LUBRICATION.

DRZEVIECKI Engineer, Paris.
THEORY OF SCREW PROPELLERS.

GONLAIEFF Constructor Russian Navy, St. Petersburg, Russia.
PROTECTION OF HULLS AGAINST ATTACK BY RAM AND TORPEDO.

HAUSER Naval Engineer, Paris, France.
ADOPTION OF A RATIONAL SYSTEM OF UNITS IN NAVAL CONSTRUCTION.

HOLZAPFEL Engineer, London, England.
FIGHTING SHIPS OF THE FUTURE.

ISAKSON Lloyd's Inspector, Stockholm, Sweden.
NOTES ON THE TONNAGE LAWS OF THE VARIOUS COUNTRIES.

JAQUES Member Council S. N. A. & M. E., Boston, Mass., U. S. A.
ARMORED SUBMARINE BOATS.

DE KODOLITSCH Austrian Lloyd's, Trieste, Austria.
THE USE OF A GRAVING DOCK FOR MODEL TRIALS.

LABAT Engineer, Bordeaux, France.
FORMULA FOR PRE-DETERMINING THE SPEED OF VESSELS—MARINE RAILWAYS.

MOISSENET Engineer, Cherbourg, France.
TOWING MACHINES AND APPARATUS FOR STEEL TUGS.

MONTUPET Engineer, Paris, France.
MARINE BOILERS.

MULLER Captain, Paris, France.
THE EVOLUTION OF FRENCH SAILING VESSELS DURING THE PAST THIRTY YEARS.

RATEAU Engineer, Paris, France.
THEORY OF SCREW PROPELLERS.

RENNER Engineer, Cologne, Germany.
ELECTRICAL EQUIPMENT OF SHIPYARDS.

ROTA Naval Engineer, Rome, Italy.
THE RESISTANCE OF HULLS.

TROMP Ex-Artillery Officer, Rotterdam, Netherlands.
SUBMARINE BOATS—COMPARATIVE STUDY ON SCHEDULES OF WEIGHTS FOR WAR VESSELS.

TURC Lieutenant Mediterranean Squadron, France.
NON PITCHING AND ROLLING HULLS.

Those who intend to present communications are urged to send a prompt notification to M. Hauser, ingénieur de la Marine, en retraite, Secrétaire général, rue Meissonier, 4, Paris, France, giving the subject of the proposed paper. The papers themselves are to be accompanied by a brief résumé, and statement of conclusions reached, and are to be sent in not later than June 1 next. After that date they will be received for presentation to the Congress only upon the special recommendation of the Commission of Organization. Authors of such communications who will not be able to attend in person can have the papers presented by some other member of the Congress by notifying the Commission of Organization to that effect.

IN these pages we recently referred to an announcement concerning Columbia University, which was very widely published in the press of the country, to the effect that President Seth Low "shared the opinion of the faculty that it is highly important for the University to pre-empt the field of Marine Engineering without delay." We have received from F. R. Hutton, Professor of Mechanical Engineering of Columbia University, a letter in which he takes upon himself the responsibility for the document from which the published extract was made. This document—prepared for the information of the Trustees of the University—was prepared, says Prof. Hutton, "without any reference whatever to the excellent and creditable work done outside of New York," and the pre-emption expressed referred exclusively to the field in and around the port of New York. "The location of Columbia University in the port of New York, with the Navy Yard and the great Trans-Atlantic companies at its doors, makes this field," in the opinion of the College authorities, "a field of immediate availability, and would constitute for Columbia University an element of great strength in these courses." Prof. Hutton advises us that the University has secured the services of Prof. William Ledyard Cathcart as a professor of the Department of Mechanical Engineering, "having in this action a definite purpose with respect to the inauguration of the Marine Engineering and Naval Architecture courses, as soon as the time should be ripe." Prof. Cathcart received his professional training at the Naval Academy, and was a member of the late Engineers Corps of the United States Navy. Other educational facilities at the port of New York, for students of Marine Engineering and Naval Architecture, are soon to be provided by the New York University as a department of the School of Applied Science. The location of this school in the buildings at University Heights, not far removed from the shipyard at Morris Heights, on the Harlem River, is considered as an advantage, giving the students an opportunity of conveniently witnessing the practical construction of vessels. The new department will be under the guidance of Prof. C. C. Thomas, a graduate of Leland Stanford and of the School of Marine Construction, at Cornell University. Since graduation Prof. Thomas has been engaged in the practice of his profession in shipyards on the Lakes and the Atlantic Coast.

AT Cincinnati, Ohio, May 15 to 18, the forty-first meeting of the American Society of Mechanical Engineers will be held. Technical sessions will commence on Wednesday morning, May 16. About a dozen papers, on subjects relating chiefly to land practice, will be read at the meeting and discussed. Excursions to local manufacturing establishments are arranged for, and indoors the social features include a reception and conversazione. There are many important workshops and engineering plants in the vicinity of Cincinnati which can be easily reached.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS—VII.

BY DR. WILLIAM FREDERICK DURAND.

§4. BOILER SCALE. (Continued.)

Scale Prevention, Salt Water.—Turning now to boilers in which sea water may form a portion of the feed, it will be of interest to first note briefly the historical development of the modern situation.

In the early days of marine engineering, the temperature and pressure of the steam were low, and the jet condenser was in general use. The feed water which was drawn from the mingled condensing water and condensed steam was but slightly fresher than sea water, so that large amounts of solid matter were thus fed into the boiler. In consequence the density would have risen rapidly had it not been kept down by blowing off a part of the water in the boiler of relatively high density, and replacing it with the salt feed of lower density. Had the sulphates of calcium and magnesium thus brought into the boiler been completely deposited, enormous quantities of scale would have been formed, and this method of operation would have been quite impracticable. Due, however, to the moderate pressure then in use and to the fact that the density was kept usually between 1 3-4 and 2, the salts were held fairly well in solution, and but a moderate amount of scale was deposited.

As steam pressures advanced, however, beyond 40 or 45 lbs., conditions were reached under which first the calcium sulphate and later magnesium sulphate and other salts are completely deposited. Under such circumstances blowing off to reduce the density of the water will only make matters so much the worse, for the lower the density is to be maintained, the greater must be the amount blown off, and hence the greater the amount of extra feed, and the greater the amount of scale forming salts brought into the boiler, all of which will be deposited.

It became therefore necessary to abandon the use of the jet condenser and salt feed. Its place was taken by the modern surface condenser. So long as this condenser is perfectly tight the feed water consists of the condensed steam, and is therefore almost perfectly fresh water. Due, however, to steam leaks at the various joints, seams and glands, to the occasional use of the steam whistle, and to the use of steam in certain auxiliaries from which it is not returned to the condenser, there will be a continual shortage in the feed water which under usual conditions will be found between say 2 and 5 per cent. Until recent years this shortage was made up by the use of sea water obtained usually by opening, as circumstances required, the *salt water cock* connecting the salt water side of the condenser with the steam side. It is very difficult to keep the tubes of a surface condenser packed perfectly tight, and in some cases the condenser was allowed to run a little leaky, simply to make up in this way the salt feed required.

Due to this admixture of salt feed, the scale forming salts of which are all deposited in the boiler, there will be a gradual formation of scale greater or less according to the length of the run and the proportion of salt feed make up.

In recent years experience has clearly shown that the dangers of overheating and the general bad effects due to the presence of scale are more and more pronounced as the pressures are higher. It has become therefore more and more important to prevent so far as possible the entrance of any sea water into the boiler, and thus avoid the formation of scale with its troubles and dangers. To this end, in modern practice, the make up feed is provided by an evaporator or in some cases by feeding one boiler with salt feed and thus restricting the scale formation to this boiler, while the condensed steam from all the boilers is returned to the other ones as feed. In all such cases it will be noted that this scheme amounts to a transfer of the use of salt water and the formation of scale from the boilers in general to the evaporator, or to the particular boiler in which it is allowed to accumulate.

It is rare that the condenser can be maintained perfectly tight, so that even under the best practicable conditions there is apt to be some passage of sea water into the steam side of the condenser, and thence into the boiler. Under the best conditions the amount of scale formed, however, is so small that commonly no special treatment is attempted, and the scale is allowed to deposit, and is then removed at the regular periods of inspection and overhaul.

Some attempts have been made to prepare sea water by the removal of the calcium sulphate in a separate vessel before entering the boiler. This may be done by the use of sodic fluoride which causes the sulphate to separate out and settle to the bottom as a fine powder. The remaining water is practically free from this substance and may be used for boiler feed without fear of causing scale.

Soda ash and other alkalies have sometimes been used in boilers, with feed water containing sulphate of lime. They act by converting the sulphate into a carbonate, and thus into a somewhat less objectionable form.

Barium chloride acts in a somewhat similar fashion by producing barium sulphate and calcium chloride.

The use of zinc in boilers is also by many believed to prevent to some extent the formation of scale by the reaction of the alkaline zinc chloride on the scale forming salts.

With sea-going as with inland boilers the bottom blow should be used occasionally and as the particular circumstances may demand, so as to remove the accumulation of such substances as may be thrown down as a powder or sludge and thus collect in the bottom of the boiler.

However careful the provisions for keeping sea water out of the boilers or no matter what methods may be used to prevent scale formation, it is almost sure to gradually accumulate, and assurance of safety from the troubles and dangers which may result can only be obtained from periodical examination and scaling as may be found necessary. All marine boilers must, of course, be provided with manhole plates for this purpose, and the internal arrangement of tubes, braces, furnaces, etc., should be made, so far as possible, with a view to furthering this necessary operation.

Combinations of Oil and Scale.—We have thus far referred to scale formed simply from the solid matter in the feed water. The combinations which may be formed by the deposited salts and oil from the cylinders as it

may enter with the feed water are, however, of even still greater importance, and must now be noted.

Oil coming in thus with the feed water is caught by the circulating currents and distributed more or less throughout the boiler, though by reason of its lesser weight it will tend gradually to rise and accumulate as a scum at the surface of the water. In thus wandering about, a drop may come in contact with a bit of solid matter separated from the water. The two join together, the oil forming a coating about the sulphate, and they journey on meeting and joining with other like particles. The combination of the oil and sulphate may have about the same specific gravity as the water in the boiler and hence these particles will readily move with the circulating currents, either up or down, as they happen to be flowing. They are thus swept along the heating surfaces, to which they attach themselves all the more readily by reason of their oily covering, and on either the upper or lower side as they happen to be moving with a down or up flowing current. In this way the coating gradually increases until it has attained a thickness sufficient to seriously interfere with the passage of the heat.

In other cases when the scale and oil are lighter or the water is denser and heavier, there seems to be formed at the surface of the water in the boiler a kind of oil and scale blanket or layer floating about and perhaps ultimately by the gradual increase of weight sinking and covering some portion of the heating surface. Especially is this oil "pancake," as it has been called, liable to settle should the density of the water in any way be suddenly decreased. Still otherwise should the boiler be blown down by the bottom blow, such an oil blanket would naturally settle and attach itself to some part of the heating surface. Should the boiler be then filled again, the coating would remain where attached. This shows that under such circumstances a boiler should never be blown down with the bottom blow without first using thoroughly the surface blow to remove as far as possible all such accumulations of oil or of oil and scale from the surface of the water.

The danger to be feared from this combination of scale and oil is not in its close adherence to the surfaces, but in its non-conductivity for heat. Experiments show that 1-16 to 1-8 inch of such a covering is far worse in this respect than perhaps 1-2 inch or more of scale alone. The danger to be feared is therefore overheating and collapse, and not a few cases of the collapse of furnaces and other parts of marine boilers are believed to be due to this cause.

So far as these effects are concerned it is seen that it is better to carry a high density in the boilers than a low one, so as to keep such oil and scale combinations at the surface of the water, where they may be disposed of by the surface blow.

As it is practically impossible to prevent the entrance of some scale forming materials into the boiler, the danger of trouble with oil and scale combinations is most surely prevented by keeping the oil out. To this end a cylinder oil should be used having a high point of vaporization, as the higher this point the smaller the amount carried into the condenser. Of this oil the minimum amount necessary should be used in the cylinders, and the feed water should be filtered to remove whatever oil it may contain.

ELECTRICITY ON BOARD SHIP—PRINCIPLES AND PRACTICE—XXIII.

BY WM. BAXTER, JR.

METHODS OF DISTRIBUTION.—CONTINUED.

Distribution, or junction, boxes are not absolutely necessary in a lighting system, whether located on board ship or on shore, but they serve to simplify the wiring, and also to facilitate the handling of the apparatus. From each junction box one or more circuits are run out, and upon these the lamps are placed. A lamp is liable to become disarranged, and while in some cases the defect may result in simply opening the circuit, so that the light will go out, in others it may produce a short circuit, and thus allow an enormous current to flow through it. On this account lamps should be provided with safety fuses that may be melted by an excessive current, and thus protect the generator, as well as the line wires, from the effects of such currents. To provide each lamp with a fuse would entail an unnecessary amount of complication, hence the proper procedure is to provide one fuse for each individual lamp circuit, then this single fuse will protect the circuits and generators against damage arrising from the disarrangement of any lamp in that particular circuit. If the individual lamp circuits issue from junction boxes, the fuse can be placed therein, and then when anything goes wrong with the lights the attendant knows where to look for the trouble. If distribution boxes were discarded, main lines could be run on either side of the ship, and the lamp circuits could be taken off from these at convenient points. With such an arrangement, however, the fuse would have to be unprotected, and every time they were blown out the melted metal would spatter over surrounding objects, and the flame would char and disfigure the surfaces to which they were attached, and possibly set fire to them.

The system of distribution would be the same, electrically, whether we used junction boxes or not, but mechanically the difference would be that the junctions of the main distributing lines and the lamp circuits would in one case be exposed, and in the other they would be covered. From this we can see that a junction, or distributing box, is nothing more nor less than a covering for the portion of the circuit wires where the branch circuits are connected with the main lines. If we had an unprotected system of wiring, we would place in the individual lamp circuits a switch, by means of which the current could be turned on or off as desired, if such an arrangement were necessary, and, likewise, if we use the protective system, that is, junction boxes, we will provide a switch whenever required. As the junction boxes are an additional expense, it is natural to endeavor to get as much good out of each one as possible, hence we make an effort to so arrange the wiring that a number of lamp circuits may start from the same point, and thus we increase the usefulness of each box, by making it a center from which several branches issue.

If it is not necessary to arrange the lamp circuits so that they may be cut out individually, then the distributing box can be made comparatively small, as it will only have to be of sufficient size to accommodate the fuses, but if switches are also to be provided, the

dimensions will have to be increased, and in that case if the space available for the junction box is not sufficient two boxes located at different points will have to be provided. It is not necessary to locate the switches of the lamp circuits in the junction boxes, and in many cases it is more convenient to place them elsewhere, as for instance, when the box is located in an inaccessible position; hence, even when all the lamp circuits are provided with switches, we can use a compact junction box as a center for a number of circuits by using separate switches, located at other points.

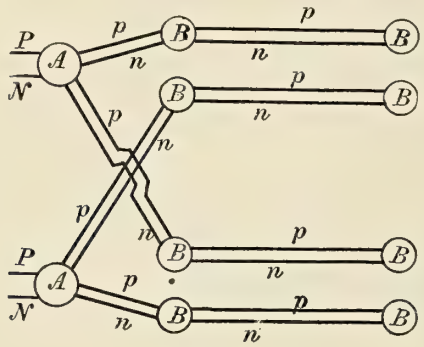

FIG. 153.

In every system of wiring for lighting purposes it is desirable to arrange the circuits so that any mishap to one may disturb the lights as little as possible. The best way of securing this result is by using a double or triple system of distribution. A double system is one in which every part of the ship, where practicable, is supplied with lights by two independent sets of circuits, and in a triple system three independent sets are provided. With the double system, if the lights operated by one set of circuits go out through some disarrangement of the wires or connections, the lights burning on the other system will still be left in service, and although the illumination will be reduced there will not be total darkness. The general arrangement of a double system is shown in Fig. 153, in which, as will be seen, the two main distributing boxes, *A A*, feed into four secondary boxes, *B B B B*. These secondary boxes are shown side by side, and all of them are bunched close together, but it must be understood that in actual practice they would be widely separated. The boxes shown in pairs indicate those used to light up the same section of the ship. In some instances the pair of boxes is replaced by one, in which case the circuits running from the two main boxes, *A A*, are run into it. This arrangement is not as perfect as that involving the use of separate boxes, for a disarrangement of the switches or other apparatus belonging to one circuit might be so extensive as to affect the other, and thus defeat the object of the double system.

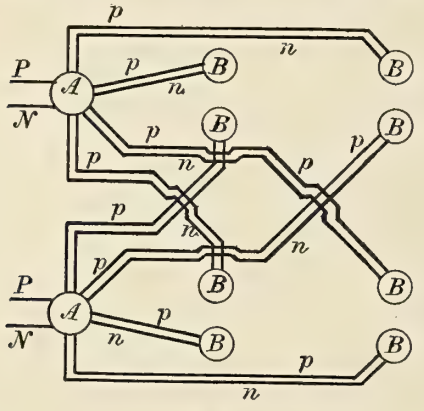

FIG. 154.

Fig. 153 does not show the best arrangement of a double system, for the reason that the *B* boxes are not entirely independent of each other. As will be seen, there are only two circuits run out from each *A* box, and the secondary boxes are connected two in series in these circuits; therefore, the failure of the first of these boxes might disable the second one. A far more complete arrangement is shown in Fig. 154, in which each secondary box, *B*, is connected with the primary box by an independent set of wires; hence, the failure of one box will not impair the usefulness of the others.

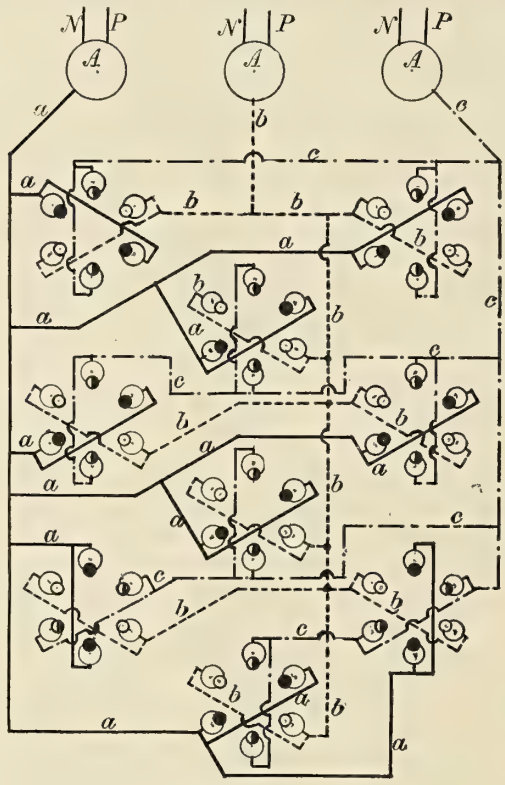

FIG. 155.

Fig. 155 illustrates the manner in which a triple system is connected with the individual lamps. These lamps may be assumed to represent nine small electroliers, illuminating, say, a dining saloon. For the sake of simplicity the circuits running from the junction boxes, *A A A*, to the lamps are represented by single lines, but this representation is correct if we keep in mind that two wires are run along each line; in other words, we can regard the lines as representing double wire cables. To make the illustration more accurate, we have shown the cables branching out into two wires at each lamp. The circuit running from the box at the left is shown in solid lines, and that running from the right hand box is drawn in dash and dot lines, while

the circuit from the center box is shown in dotted lines. Each box feeds two lamps in each electrolier, those connected with the left side box being shaded, those operated by the right side one being half shaded, while the white ones are connected with the center box. From this disposition of the circuits it will be seen that the failure of one of the boxes will only put out two lights in each electrolier. It will also be noticed that if we cut out one circuit we effect a uniform reduction of illumination throughout the entire room, which is more satisfactory than darkening one part and leaving the rest brilliant.

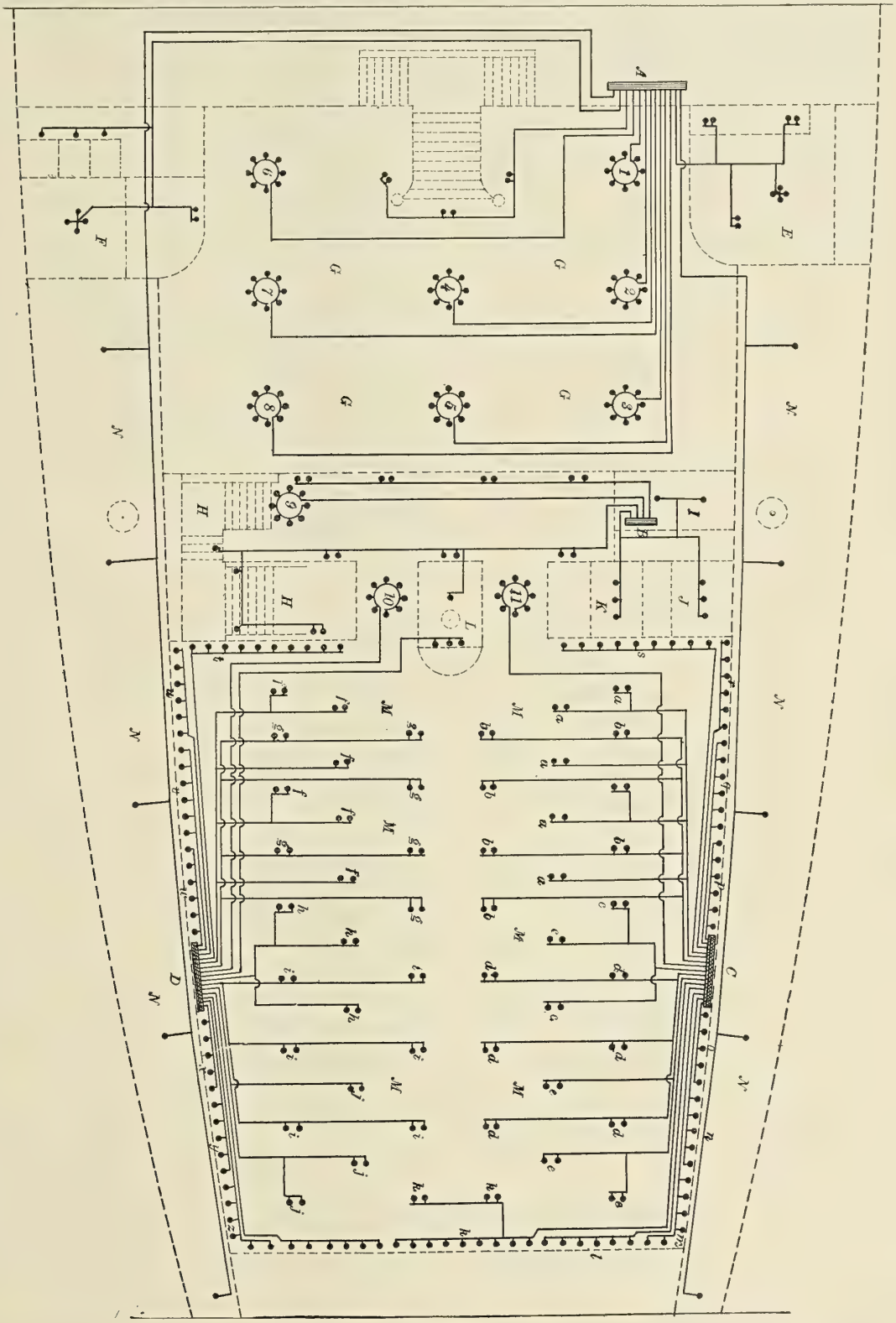

FIG. 156.

As a final example of the general method pursued in wiring, we give the illustration, Fig. 156, which shows the arrangement of lights and wiring for the dining saloon and adjoining parts of the vessel. This drawing is but a slight modification of the actual construction used in one of the large steamers running on Long Island Sound. The whole system of lamps is supplied from four distribution boxes marked *A B C D*. The first one supplies the lights in the saloon, *G G G G*, and also in the side rooms, *E* and *F*, and the outside lights at *N N N N*. The box *B* feeds the lights for the stairway, *H H*, the cashier's office, *L*, and the butler's rooms, *I J K*. The box *C* supplies one side of the dining saloon, and box *D* takes care of the other. Box *A* runs out 13 lamp circuits, box *B* furnishes four, and boxes *C* and *D* each supplies fifteen circuits. The lamps burning on the same circuit are marked with the same letter.

The outlines of the boat are drawn in broken lines so as to cause the circuits to stand out more boldly, and, as in Fig. 155, the wiring is represented by single lines. The boxes *A, C* and *D* should be connected with the switchboard by at least two circuits, each one supplying its proportion of the lamp circuits. With two circuits from the switchboard, box *A* would be arranged with electroliers *1 3 4 8 7* and lights in room *F* connected with one circuit, the other circuit being connected with the balance. Of the lamps supplied from box *C*, the groups *a c e k m o p* and *r* should be connected with one circuit and the remaining ones with the other. The lights fed from box *D* should be arranged in the same way. These boxes should be provided with switches by means of which the lamp circuits could be connected with either circuit coming from the switchboard, then in the event of the failure of one circuit all the lights could be operated by the other.

ENGINEERS' DICTIONARY.—XXVII.

Lock Bolt—A bolt used to lock or secure some part of a mechanism so that it cannot become loose by jarring or pounding. See also under *Bolt*.

Lock-Nut or **Jam-Nut**—See under *Bolt*.

Low-Pressure—In a compound or multiple expansion engine, where the steam is expanded in stages through a series of cylinders of increasing sizes, the *low-pressure* cylinder is the largest and last of the series, and from this the steam goes to the condenser. The term *low-pressure* is also sometimes used in referring to a condensing engine as opposed to a high-pressure or non-condensing engine, and in a vague and general sense in referring to any machine or method of operation in which the pressures involved may be relatively low.

Lubricator—In general, any device for applying oil or other lubricant to a bearing or place where required. In particular, a device for feeding cylinder-oil into the steam pipe or throttle valve chamber, where it may be caught by the steam and carried on to the valve chests and cylinders. The essential parts of a lubricator are a small vertical pipe attached at its upper end to the steam pipe, and at its lower end to the chamber containing the oil, the latter being connected to the steam pipe or valve chamber. Steam is admitted to the vertical pipe, where it condenses, thus forming a vertical column of water connecting to the bottom of the oil chamber. The pressure upward of the water against the oil is therefore equal to the steam pressure plus the pressure due to the head of water in the vertical pipe. The pressure opposing the flow of oil into the steam pipe or valve chamber is on the other hand practically that due to the steam. The extra pressure due to the head of water is therefore available for forcing the oil out of the chamber and into a passage leading to the steam pipe. By this means, as controlled by a regulating valve, the oil is forced, drop by drop, out of the oil chamber at the top, the water entering at the bottom gradually taking its place. A small gauge glass is placed on one side to show the level of the water and oil within the chamber, while a short length of glass tube filled with water forms a part of the passage followed by the oil drop. Its passages upward through the water is plainly visible, thus showing clearly that the apparatus is working properly. Such an attachment is called a *sight-feed*, and the whole device a *sight-feed lubricator*.

Lug—An extension or projection of metal from the main body of the part, thus providing a means of connection or fastening of one part to another.

Main Bearing—A name frequently given to the crank-shaft bearing or pillow-blocks.

Main Steam Pipe—The main line of steam piping from the boiler to the engines, as distinguished from the various auxiliary pipes and connections.

Manhole—In general a hole or opening cut to allow the passage of a man. Thus a manhole in the shell of a boiler is an oval or elliptical hole cut to allow the entrance of a man to the interior of a boiler for purposes of examination and repair. The usual size of a boiler manhole is 11 in. by 15 in. Similar openings may be made in the shell of a condenser, and also in the inside skin and throughout the inner structure of a ship's "double bottom." Circular openings with suitable covers are also frequently provided in the heads of large steam engine cylinders for like uses.

Manhole Cover or Plate—A cover fitted over a manhole and secured by bolts or dogs, with suitable arrangements for a steam or water tight joint as the case may require. In fitting a cover to a boiler manhole, a reinforce ring is secured about the hole in order to provide local strength and stiffness, and when the hole is cut in the curved shell, to restore in some measure the metal removed by the hole. In some cases —hand or mud holes—the reinforce metal is obtained by flanging the plate around the hole.

Manifold—A pipe or chamber serving to connect together in common a large number of pipes or tubes. Manifolds are used in the construction of many forms of water-tube boiler, and also in forming steam heating and refrigerating coils, etc.

Mean Pressure—The mean or average of a series of varying pressures. Thus, we may refer to the mean pressure on a bearing surface, the mean pressure on a piston, etc.

The U. S. training ship *Buffalo* will leave one of the Atlantic ports shortly with several hundred landsmen on an extended cruise. The first port of call will be, probably, Gibraltar.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—I wish to get out a triple expansion engine design, and would be obliged if you would outline the work from the beginning, giving what should be first known and the order of procedure. J. W. H.

A.—In the design of a triple expansion engine for marine work a great number of questions must be considered before calculating dimensions and proportions. Weight, space occupied, grade of material and the nature of the service of the engine will all be factors having an important bearing on the design. A torpedo boat engine made of the finest material, with high piston speed and not a pound of surplus metal in its construction, is quite a different affair from the engine of the ordinary cargo boat, although both of them may develop the same power.

It would be impossible in this answer to go into details of the different types, the question of cylinder proportions, valve setting and crank sequence, as opinions differ considerably on these matters, and experience usually decides the details adopted. In designing parts, etc., a good book of rules such as Seaton & Rounthwaite's pocket book of marine engineering would be of great value.

In the draughting rooms of most of the engine building concerns, the design of a new engine usually consists in remodeling and altering the plans of engines previously built with the view of using old patterns of parts, and in this manner the design can be produced very quickly. In an original design, however, it is an affair which takes considerable time. To give a short synopsis, the following is the usual method of procedure :

After determining the power necessary to propel the vessel at the required speed, the propeller wheel is designed or decided upon, in which case the assumed slip, diameter, and pitch will determine the number of revolutions per minute of the engine. Then on deciding the piston speed, the stroke of the engine can be calculated, and the stroke, revolutions, horse power and boiler pressure being known, the diameters of the cylinders can be computed. Then the different port areas and valve settings are figured.

After deciding upon the type and position of the valves the design can be started, by drawing out separately each cylinder with its parts, valve and stem, cover, piston and stuffing box. Beneath each cylinder sketch its crank shaft with the bearings and eccentric sheaves, taking care to see that there is room to remove coupling bolts, eccentric sheaves, etc. Then the distance between centers of cylinders can be decided upon.

Next decide on the style of crosshead, guide shoes, connecting rod and crank pin box, and make a separate end view of these, showing the crosshead in the top and bottom positions, and the angles of the connecting rod at different portions of the stroke. By this means the position of the guide faces are determined in relation to the crosshead and connecting rod, and allowing the necessary clearance between the stuffing box and crosshead in the top potition the end view of a cylinder may be sketched in. The center of the shaft is then a fixed point.

Now show the crank pin box in different positions of the stroke and thereby determine the size of the crank pit, bearing in mind that in this case, as well as for all other parts, there must be room left for overhauling or taking parts adrift. The shape of the bed plate can then be worked in, and this will be determined by the shape of the bottom of the ship, or tank top, or stool to which it is to be fastened.

Next the positions of columns and their attachment to the cylinders and bed plate can be considered, giving them all the same slope, and if possible making them all duplicates of each other, so that the same pattern can be used with minor alterations for each. Next design the valve stem guide brackets, then the butt ends of the valve stems, the saddle blocks and links.

A separate sketch can then be made showing the different positions of the link at various points of the stroke, and after determining the clearance between the link in its highest position and the valve stem guide the length of the eccentric rods can be ascertained.

Next determine the centers of the drag links, rock shaft levers, and of the rock shaft itself, by placing the link in the ahead and in the astern positions. Locate the rock shaft so that it can be conveniently attached to the columns.

All these plans can then be combined, and the arrangement of the condenser drawn in. The condenser is usually made about the same length as the engine, if attached to the bed plate, and care must be taken that the drain is sufficiently high above the air pump suction. There are so many designs of condensers that it would be impossible here to give any details, and this applies also to the minor engine attachments.

Q.—Can the speed of vessels be increased by twin screws over that attained by a single screw? If so, what percentage gain in speed?

I have a single screw propeller on a yacht 65 ft. long and have attained a speed of 12 miles per hour, developing 60 H. P. Could the speed be increased with twin screws and two engines developing 30 H. P. each?

The propeller now used is 38 in. dia. and 60 in. pitch.

The speed of 12 miles was with 300 revolutions per minute and with a loss in slip of about 30 per cent.

A. D. R.

A.—The whole question turns on whether or not you can apply your total power of 60 I. H. P. more efficiently with two screws than with one. To judge of this point we should require somewhat fuller information than is given regarding the single screw. Making the best use of what is given, however, and examining the performance of the single propeller of 38 in. dia. and 60 in. pitch at 300 revolutions and a speed at 12 miles per hour, it appears from the most reliable propeller formulæ that it should be able to take care of about 60 I. H.P. with a very fair efficiency—within a few points probably of the best that could be gotten from any propeller. It follows therefore that with the propeller you are already using you are applying your power with an efficiency not far below the best that can be hoped for, and hence that you cannot expect to do very much better with twin screws and the same power.

At the same time the indications are that with twin screws carefully designed and adapted to the circumstances of the case a small increase in efficiency could be expected, and a corresponding increase in speed, but not probably greater than ¼ to ½ mile per hour. This gain, it should be noted, would not be due primarily to the use of *twin* screws rather than *single*, but simply to a slightly better design and adaptation to the circumstances of the case. Quite as good results could undoubtedly be gotten from a single screw slightly modified in size and proportion, assuming of course that there are no special limitations to the diameter, revolutions, etc.

In other words the question does not turn on whether one screw or two are employed, but on how correctly they are designed to meet the circumstances of the case.

Referring again to the case in hand, it is therefore very doubtful if the change from single to twin screws would be justified by the expectation of any really considerable increase in speed.

It must be remembered that this opinion is based on the supposition of equal power given to both twin and single screws. If it were desired to considerably increase the power and there were limitations on the diameter of the propeller, then it might become advisable to change to twin screws to avoid loss at the higher powers.

M. Marcel Delmas, 10 Boulevard Emile Augier, Paris-Passy, has charge of the Report of the "Congres de Mécanique de l'Exposition universelle, in the department of applications of electricity to the various apparatus of haulage, hoisting, etc. (including cranes, elevators, winches, swing-bridges, pumps and other such mechanisms), and particularly desires information regarding the economic side of the matter. He requests that all, whether exhibitors or others, who are willing to assist in the collection of this data send him, at the address given above, statements of costs of installations, of exploitation and incidental expenses, especially where a comparison can be made with costs of the older systems under similar circumstances. All publication and illustrations will be welcome if authentic and exact in statements of facts and data.

In the Government ordnance factories at Woolwich, England, there are 25,000 workmen employed. At the Krupp, Essen, works about the same number are employed.

TECHNICAL PUBLICATIONS.

HYDRAULIC POWER ENGINEERING. By G. Croydon Marks. First edition, 1900. Crosby Lockwood & Son, London; D. Van Nostrand, New York. Size 6 by 8. Pages 360. With over 200 illustrations, chiefly drawings. Cloth, $3.50.

This new work is built upon the little book entitled, "Hydraulic Machinery," which the author brought out in 1891. It is a distinct gain to the profession, as there are very few good works on this subject. The author has in all cases illustrated and described the latest forms of apparatus built by the various firms who make hydraulic machinery their specialty; and has not, like some others, made use of engravings of the earlier forms from the proceedings of various engineering societies.

This is such a very useful book that we should like to see it accompanied by a more comprehensive index for purposes of ready reference; and if Mr. Marks would add more tables and formulæ for the power required in forging, flanging, shearing, etc., by hydraulic machinery he would increase the practical value of the work.

Part 1 deals with the principles of hydraulics.

Part 2 will be found very useful by the young engineer, as it deals with details of design and points out mistakes which designers are apt to fall into.

Parts 3 and 4, on Joints and Valves, are worthy of the most careful study. Many hydraulic plants have been thrown into disrepute from leaking valves and joints. A very full and complete description of the manufacture of cup leathers is here given and the necessary dies shown in detail.

Part 5, on Lifting Machinery, contains a great deal of information which will enable the student to work out the size of rams and their details. Special attention may be called to Table IX, giving Coefficients of Efficiency of Pulley Wheels Turning on Pins; and also to page 173, showing Efficiencies for Multiple Hoists. Many types of hydraulic cranes are illustrated and described in this section, and a chapter is devoted to a description of accumulators and intensifiers. If the author had been writing particularly for American engineers he would have done well to impress upon them the great advantage gained by the use of large accumulators.

Part 6, Hydraulic Presses, is very complete and many useful hints and formulæ to aid in designing are given. Chapters XIV, on Sheet Metal Working and Forging Machinery, and XV, on Hydraulic Riveters, simply illustrate and describe the latest machines used for this work. Their value would be much enhanced by the addition of practical data on the power necessary to do this work.

In Part 7, the various forms of Pressure Pumps are briefly described. Part 8, on Hydraulic Motors, deals in some detail with Turbine and Hydraulic Engines and will be found very useful.

The last chapter, on Recent Achievements, refers to the large hydraulic lift dock built by the Union Iron Works of San Francisco; the Tower Bridge, London; Water Balance Railways; the Glasgow Harbor Tunnel; Tunnel Lifts in which the large hydraulic elevators built by the Otis Elevator Co. are operated; and lastly the Niagara Power Plant is illustrated and described. The author is to be congratulated on the marked advance shown in this work, and on the very excellent manner in which it has been produced.

THE GAS ENGINE HANDBOOK. By E. W. Roberts, M.E. First edition, 1900. The Gas Engine Publishing Co., Cincinnati, O. Size 3 1-2 by 5 1-4. Pages 220. With 39 original illustrations. Cloth.

As its name implies, this is a little book intended for the use of persons having practical charge of gas and gasolene engines, and with a view to best serving the needs of such men thermodynamics and high mathematics have been carefully kept out. The book is a good practical discussion of the subject, giving the fundamental principles underlying gas engine operation, together with considerable practical information as to the handling of engines and remedying any ordinary troubles which may arise.

Taking into consideration the specific scope of the book, chapters 15 to 21 inclusive, relating to the dimensions of the various parts of gas engines, might profitably have been omitted to make room for advisable expansion of the chapters on practical handling. In chapter 14 there occurs what seems to be an error of reversed formulas; the formula given for the compression curve is $PV^{1.3} = \text{constant}$, and the formula given for the expansion curve is $PV^{1.35} = \text{constant}$. The compression curves of about twenty diagrams examined by the reviewer showed an average of $PV^{1.35}$ and the expansion curves showed the average of $PV^{1.3}$, exactly the reverse of the formulas given in the book under discussion. However, the difference is so slight and the variation from any formula so uncertain in practice, that one might take either of the values given for either of the curves without involving a very serious error.

The portion of the book relating to marine work is restricted to one page, in chapter 23, on which are given formulas for the diameter of the propeller and the capacity of engine required for small boats. The formulas for ascertaining these figures are extremely empirical and apparently crude; that for horse-power taking into consideration only the length of the boat and not its speed or displacement, while that for the diameter of the propeller is based upon the horse-power and revolutions per minute, no consideration being given to the speed of the boat. There is no discussion of gasolene or oil engines designed particularly for marine work.

SALVAGE AWARD.—Salvage services are not always as remunerative as is popularly supposed. An award of only $82,500 was made by the British Admiralty Court to the owners of the S. S. *Asloun* for rescuing the steamship *Waikato*, and towing her about 2,600 miles to port. In our issue of January last we gave details of this most remarkable rescue, performed under very trying conditions. The *Waikato* was out 157 days, and reinsurance had gone to 12 per cent., when she was brought into port by the *Asloun*. In the evidence in court the appraisal of the *Waikato* and cargo amounted to $665,000. Her crew numbered 50, all told.